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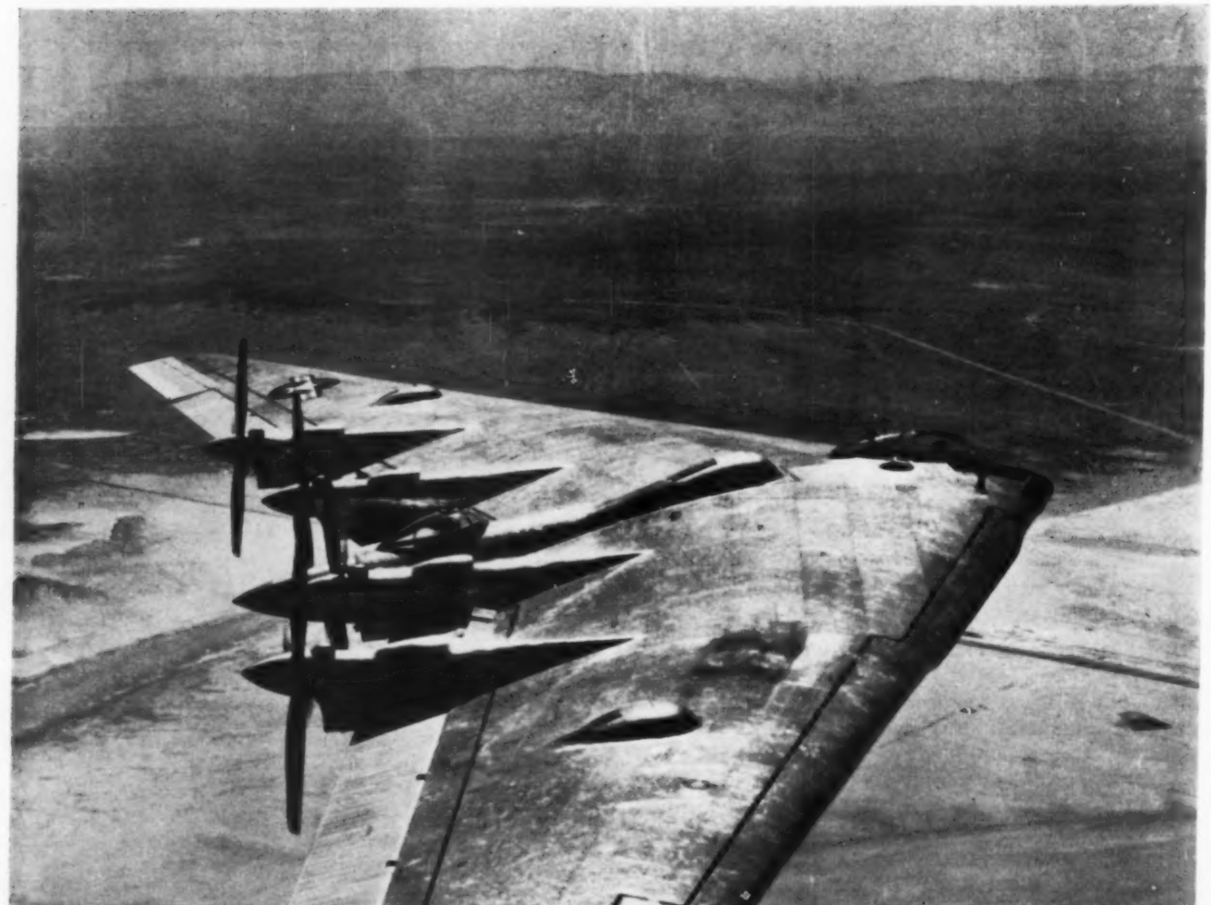

Northrop B-35 Flying Wing

(Powered by four Pratt-Whitney R-4360 engines, the B-35 can carry five tons of bombs 10,000 miles at a maximum speed of more than 350 miles an hour.)

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VOLUME 70
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GEORGE A. STETSON, *Editor*

Roy V. Wright

ROY V. WRIGHT, Fellow, Past-President, and Honorary Member of The American Society of Mechanical Engineers, whose death occurred on July 9, was best known to recent readers of this magazine as the author of numerous papers on citizenship. Editor, publisher, mechanical engineer, and public servant, Roy Wright was born in Minnesota in 1876, the year of the Centennial Exposition in Philadelphia, where, symbolized by the great Corliss engine, was seen the fulfillment of the promise of American "genius and skill" that President Polk had sensed thirty years before at the National Fair in Washington. Here also, Wallace and Gramme exhibited electric dynamos that excited little popular interest, although the world was standing on the threshold of the electrical age, and engineers were becoming conscious of the role they played in industrial and economic developments.

At the Columbian Exposition in Chicago, which Roy Wright visited while still at school, electricity and electric lighting made a more popular appeal. Men's hopes for the future were high. Henry Adams, at Chicago, "lingered among the dynamos, for they were new and gave to history a new phase"; and here he found the "first expression of American thought as a unity." A capitalist system had been adopted. The youthful Wright left Chicago with the notion that he was living in an electrical era and that he should become an electrical engineer. Later he was to comprehend that the American unity would come under attack from men whose minds could not accept the changes engineering was to introduce, and that, to preserve it, men like himself would have to discharge their civic responsibilities with vigor and intelligence.

But it was as a mechanical engineer that Roy Wright was graduated from the University of Minnesota in 1898 and it was as a machinist apprentice for a railroad that he started his engineering career. He was beginning at the bottom, and the challenge of civic responsibility lay in the future. For fifty years his life was devoted in one way or another to the railway field, first as a mechanical engineer, and from 1905 on as writer and editor of publications serving the railways and the railway-equipment industry. By 1911 he had become managing editor of *Railway Age* and editor of *Railway Mechanical Engineer*. At the time of his death he was vice-president and secretary of the Simmons-Boardman Publishing Corporation, publishers of these and other trade journals and cyclopedias, and his work had forced him into ever-widening fields, including that of citizenship.

In addition to the talents Roy Wright displayed as a railway engineer in early life and later as editor and publisher, there existed in him a capacity for enlarging the horizons of the areas in which his work lay, for assessing the significance of engineering in terms of social significance and public service, and an interest in men as individuals whose lives encompassed more than the narrow round of tasks imposed on them by their employment. He had an eager curiosity about whatever seemed to be of significance for his work. The possibilities he saw in electrical engineering as a boy at Chicago were as characteristic of his mental perspective as was his interest in the efficiency methods that Harrington Emerson was later to install on the Santa Fé system and the challenge that he recognized and met in civic responsibility.

Dr. Wright was particularly active in The American Society of Mechanical Engineers and his services to it and to related organizations are well known. He gave extensively and wholeheartedly of his time and energy. During his ASME presidency he traveled from coast to coast, visiting all of the 71 sections and 66 of the then 108 student branches. These visits brought him face to face with Society affairs as viewed by members all over the nation. He was quick to discover what common points of interest or misunderstanding existed, and early in his term he began a series of letters to the members, published in the ASME News, in which he discussed these subjects clearly and simply. Although the year's work proved to be strenuous and demanded a major part of his time, he found it to be rewarding for him and the Society. For years afterward young men who had met him during his term of office applied to him in person and through correspondence for the advice and friendly counsel he was always eager to give.

Interest and service in the numerous areas of his business and professional life developed in Roy Wright the qualities of leadership which eventually bore fruit in practical politics. He was not unique as an engineer in politics; many others had distinguished themselves in that field. But he was a pioneer in organized efforts to interest engineers and particularly young men, in preparing themselves for intelligent and effective work in the political arena. Both he and Mrs. Wright worked valiantly in a campaign to elect Herbert Hoover, and although the efforts of the Engineers' Hoover for President Movement were not successful in 1932, Roy Wright had become deeply interested in politics and had sensed keenly the needs of his community and the nation for active participation on the political firing line by men of high purpose and intelligence. He tackled the problem of his own civic responsibility along lines which he

has since advocated for others—begin at the bottom and work up in a political organization. Thus he became successively a freeholder of Essex County, N. J., member of the Republican State Committee, and state senator. He devoted himself wholeheartedly to the intensely practical task of running for office and getting himself elected, speaking at rallies and entering vigorously the rough and tumble of political debate. There was much for an engineer to learn, but Roy Wright learned it; and in learning it his zeal for active participation by the engineer in the discharge of civic responsibilities grew. A new task he therefore imposed on himself. Not only must he play his part and exercise his leadership in politics; he must inspire and encourage other engineers to follow his example.

In this new task Roy Wright's methods were as direct and as practical as they had been in politics. He began at the bottom. For years he led discussion groups on the subject at the Newark College of Engineering. He addressed local sections, student branches, and engineering and other organizations whenever the opportunity presented itself. He organized the ASME Engineers Civic Responsibility Committee and surrounded himself with a group of kindred spirits who developed programs for engineering meetings, a manual and a "measuring stick," and an interchange of opinion and experience by correspondence. With Mrs. Wright he published, in 1938, a book, "How to Be a Responsible Citizen." As recently as the issue of July, 1948, he addressed readers of MECHANICAL ENGINEERING in an article, "Engineers and Politics," in which the high ideals of citizenship he held for engineers were given force and direction by very practical suggestions on what the individual can do and how the newcomer to politics can get a start.

The responsibility of the engineer, the glorification of the engineering profession, the urgency for engineers to take a more positive and effective place in the affairs of their fellow men in the community, the state, the nation are familiar subjects for inspirational addresses. There are many calls to action in such addresses; too few examples of it in the lives of the speakers; and little of the practical know-how by which success may be achieved. Roy Wright issued calls for action, but he also put into practice what he preached and he taught other men how to follow his example. In this field and for these traits, he will be remembered among engineers, not only as an engineer and an editor but as a pioneer in teaching other engineers how to develop talents for political leadership and how to exercise these talents effectively.

RESA

AT a dinner meeting held in New York in June members of the executive committee of the Society of the Sigma Xi explained to representatives of some fifty industrial research organizations the purposes and work of the Scientific Research Society of America.

RESA is a new scientific society organized by Sigma Xi and designed primarily to meet the needs of industry and research workers in industrial laboratories. It will be remembered that Sigma Xi is a scientific "honorary" society operating in the colleges and universities. Organized more than sixty years ago at Cornell it spread throughout the universities of the nation as a society through which graduating and graduate students in science and engineering who showed promise in research could be recognized and encouraged by contacts with older men who had made their mark in these fields. As teachers and research workers moved from colleges where no Sigma Xi chapters had been installed to institutions where the society was a going and vigorous organization they became eligible for membership. And as members left the universities where they had been elected to membership and went to others where no chapter existed, they became leaders of local groups who petitioned the parent Society for the establishment of a chapter in that institution. Thus Sigma Xi has gradually grown in number of members and chapters until today it holds a position of great influence in almost every major university.

There existed, however, a blank spot in its organization which badly needed to be filled, that of the industrial research center which was not a part of a university and hence could not petition for a chapter. In these areas, which have grown tremendously, particularly in the last decade, there are hundreds of Sigma Xi members no longer affiliated with university chapters and even more engineers and scientists who were graduated from institutions in which no Sigma Xi chapter had been installed at the time of their residence and others whose scientific talents had not been demonstrated at the university or had flowered late in the industrial atmosphere. The parent society has grown continuously more conscious of this gap in its organization during the past few years and has been seeking a means by which it can be filled. Sigma Xi "clubs" were established in a few industrial laboratories as a stopgap means of meeting a growing need for an association of kindred spirits in science and engineering where the stimulus of intellectual contacts and of interchange of knowledge and friendship between men working in separate fields would be enjoyed. The formation of the Scientific Research Society of America, under the aegis of the Society of the Sigma Xi, is the result of the efforts of the parent society to extend its influence and benefits to scientists and engineers in the industrial field.

Copies of the new constitution were distributed at the New York meeting and the background of needs and plans to meet them was explained. Questions and discussion demonstrated a lively interest in the new organization. Engineers and scientists in industry who feel that they would like to form a branch of the new society were encouraged to apply to the Sigma Xi headquarters at New Haven for the necessary information. RESA should become as popular and as widespread an organization for persons in industrial research as the parent Society of the Sigma Xi has been in the universities, and it may well be that in the future its members will outnumber those of the originating body.

Some Engineering Problems of
ATOMIC-ENERGY RESEARCH

By O. C. SIMPSON

ASSOCIATE DIRECTOR, CHEMISTRY DIVISION, ARGONNE NATIONAL LABORATORY, CHICAGO, ILL.

THERE are several large fields of atomic-energy research where engineering skills are obviously deeply involved. I wish to name some of these fields, but not all, and to present typical problems in some detail from several of them. Before proceeding to this, I would like to remark that there is no problem in atomic-energy research, or in any other research for that matter, which does not involve engineering. I presume the converse can be said equally well. For many years research scientists have claimed that they really are not physicists, chemists, biologists, and so on, but for the most part are plumbers, machinists, and glass blowers. These classifications, of course, are far from engineering categories, but they indicate the close connection with technology. I might point out, since I am a chemist, and probably can get away with it, that plumbing is just a good earthy name for chemical engineering. Further, it is worth remarking that the recent building programs at several of the Atomic Energy Commission sites have made it necessary for a good many of our research scientists to learn quite a bit about architectural engineering. Conversely, it has been necessary for the contracting architectural engineers to learn a great deal about atomic energy.

PARTICLE ACCELERATORS

The first large field which I would like to mention, where engineering plays a major role, is that field involving the design and construction of particle accelerators. As is well known, there is at the Radiation Laboratory in Berkeley, Calif., a mammoth 184-in. cyclotron in operation, which certainly represents a tremendous achievement in the welding together of engineering and fundamental science. This machine, although in operation only a little over a year, has produced some astounding results in the field of nuclear science. However, as a recent press release from the Atomic Energy Commission has indicated, there is to be built at Berkeley a much larger and more powerful accelerator. Instead of 184 in. this new accelerator will be approximately 110 ft in diameter. It will involve 10,000 tons of steel in the magnet and will require 5000 kw of magnet power. Similar accelerators are being planned for other sites. Below these towering mammoths stand the smaller, say, 60-in. cyclotrons, which have done yeoman service in nuclear science. It is this standard 60-in. cyclotron which I would like to pick out of the major field to illustrate some of the research problems involved. The 60-in. cyclotron has been used principally for the following purposes:

1 For the production of nuclear transformations.
2 For the study of the biological effects of radiations.
3 For the study of the physical effects of radiations.

The nuclear transformations are produced by bombarding target nuclei with fast-moving helium nuclei, heavy hydrogen nuclei (deuterons), or light hydrogen nuclei (protons), which in their passage through the target sometimes suffer nuclear collisions.

Presented at the Semi-Annual Meeting, Milwaukee, Wis., May 30–June 5, 1948, of The American Society of Mechanical Engineers.

The radiation effects, both physical and biological, are produced by the ionization and knock-on recoils obtained when these fast particles are slowed down in various materials. The kinds of reactions and effects which are obtained depend upon the type of bombarding particle and upon its energy. It would be most useful to the research scientist if these two parameters (particle and energy) could be changed at will.

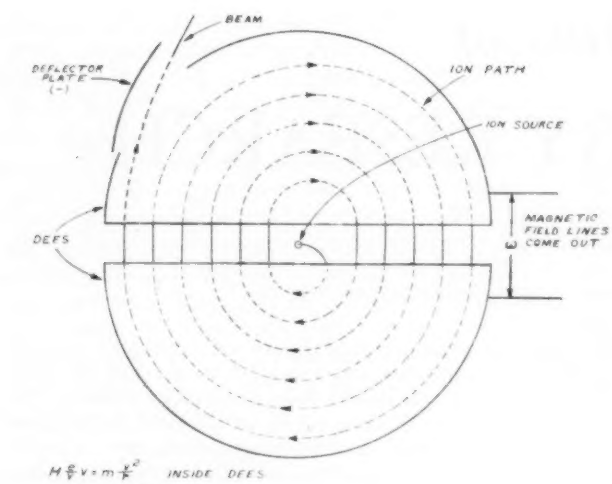
In present-day 60-in. cyclotrons, it is not possible to vary the energy of the bombarding particle in any simple and direct way. The research scientist must resort to the use of either of the following tricks: He may push his target radially into or out of the magnetic field, so that he accepts bombarding particles at different radii, thus accepting them at different energies, or he may decrease the energies of the bombarding particles by allowing them to go through thin absorbers prior to hitting the target. Neither of these tricks is entirely satisfactory because the first method involves the use of an internal probe target and with it the attendant problems of heat dissipation, and the second method, using absorbers, although it decreases the energy, also produces nonmonoenergetic particles by scattering which are no longer moving in a single direction.

The other parameter, the type of bombarding particle, also cannot be changed at will in the present-day 60-in. cyclotron. It is relatively easy to change from helium nuclei to deuterons or vice versa, since their e/m's are almost equal, but it is a major problem to change from either of these two bombarding particles to protons, especially if one wishes to continue to get the maximum energy out of the cyclotron. There may be no satisfactory solution to these problems other than to build several cyclotrons, if one desires to work with different bombarding particles and at different energies. However, I expect the future will show that a more versatile cyclotron is possible. Certainly these problems deserve active thinking by our best engineering and scientific minds.

ACCELERATING THE HELIUM NUCLEUS

Fig. 1 is a schematic representation of what happens to an ion, such as the helium nucleus, as it is accelerated between the pole pieces of a cyclotron magnet. Also there are shown a few of the simple mathematical relations involved.

As you know, the Dees of a cyclotron look very much like a shallow metal pillbox which has been cut into two halves, the two Dees and the two halves separated slightly. The Dees are inserted between the poles of a large electromagnet and, in addition, a high-frequency potential is applied between them. The path of an ion released near the center of the Dee system will be approximately as indicated in Fig. 1, provided the angular frequency of the Dee potential is $(He)/(mc)$. Between the Dees the path is approximately a straight line; inside the Dee the path is a circle whose radius is determined by the terminal velocity of the ion after its last acceleration across the Dee gap. The final energy (velocity) of the particle is determined by the final radius before deflection through the Dee wall. One should be able to vary the energy of the emerging beam by



$H\frac{e}{c}v = m\frac{v^2}{r}$ INSIDE DEES

$\frac{v}{r} = \omega = \left(\frac{H}{c}\right)\left(\frac{e}{m}\right)$

$E = \frac{1}{2}mv^2 = \frac{m}{2}r^2\omega^2 = \frac{1}{2}mr^2\left(\frac{He}{cm}\right)^2$

BOMBARDING PARTICLE	RELATIVE $\frac{e}{m}$	RELATIVE ENERGIES AT SAME FREQUENCY	MAXIMUM ENERGIES
HELIUM IONS (HELIONS)	2/4	40 MEV	40 MEV
DEUTERONS	1/2	20 MEV	20 MEV
PROTONS	1/1	10 MEV	40 MEV

FIG. 1 SCHEMATIC DIAGRAM OF HELIUM NUCLEUS AS IT IS ACCELERATED BETWEEN POLE PIECES OF CYCLOTRON MAGNET

using a variable frequency with corresponding magnetic fields, but there are complications and, to date, no one has come up with an adequate design to do this.

Fig. 1 also shows that it is possible (although not easy because of additional magnetic shimming required) to change from, say, helions to protons at the same frequency, but in so doing, one must halve the magnetic field and quarter the maximum proton energy available. The resulting 10-Mev proton beam obtainable from a 60-in. cyclotron is insufficient to produce many nuclear reactions, especially in the interesting heavy end of the periodic table.

NUCLEAR-REACTOR RESEARCH

Another major field which I would like to mention is the field of nuclear-reactor research. There are four main reasons for building nuclear reactors; for production of fissionable isotopes, for the production of other isotopes, for the production of intense neutron sources for experimentation purposes, and for the production of power. Any type of nuclear reactor whatever, including an atomic bomb, will certainly serve these four main purposes, emphasizing the one purpose over the other, according to the particular design of the reactor.

I would like to mention some of the problems involved in the design of a nuclear reactor for the production of useful power. Every nuclear reactor up to the present time involves the neutron-induced fission of some fissionable isotope. This fissioning process releases a tremendous amount of energy in the form of the kinetic energy of the two fission fragments. There seems to be no practical way in which this tremendous kinetic energy can be transformed directly into useful energy other than by the intermediate production of heat through the dissipation of the kinetic energy in the pile construction materials.

This enormous heat production must be removed from the pile by means of some coolant and transformed into useful energy by means of a heat exchanger outside the pile proper. This removal of great amounts of energy means that there will be extremely large thermal gradients in various parts of the pile where fission energy is generated. These thermal gradients are easily withstood by most metals, especially at the high temperatures which may be involved, since these materials are somewhat plastic On the other hand, if one desires to operate a nuclear reactor at an extremely high temperature, it may not be possible to use metals because of their low melting points or because of other restrictions. It may be necessary to think of a high-temperature refractory which not only must be acceptable nuclearwise, that is, it must not waste neutrons by high absorption, but also must have good thermal-conduction properties and high thermal-spalling resistance. Such materials are not easy to find.

It is here that we must call on the ceramic engineer for the development of new materials for use in nuclear reactors. We must also call upon other engineers to aid in the development of new methods of testing ceramic materials for thermal-spalling resistance. The simply stated problem of the measurement of the temperature of the surface of a ceramic is one of the first things which requires a more adequate solution than exists now.

Then there are the mechanical features of such a pile itself. If a coolant is to be circulated through a pile, the entire system will have to be a closed leakproof system. How are pile control rods to be regulated through such a closed system, surrounded by heavy shielding and operating at high temperature? How are portions of such a pile to be replaced when needed? These problems have been given considerable thought, but no really good solution has been arrived at as yet. The participation of mechanical engineers in such considerations is essential.

ISOTOPIC-SEPARATION METHODS

The third major field in atomic-energy research which may be discussed briefly is that involving development of new methods and improving old methods of isotopic separations. During the war large plants were set up in Oak Ridge to separate isotopes (principally uranium isotopes) by means of barrier diffusion on the one hand, and by electromagnetic deflection on the other. The world knows how successful these plants were, but I do not wish to emphasize their importance in weaponeering, or even in the production of isotopes for tracer or other nuclear work. Rather I would like to point to one field of engineering, vacuum engineering, which grew to manhood as a result of the development of these plants. The full import of this type of engineering cannot be imagined, but it will certainly be great. Successful as these plants are, nevertheless there is a tremendous need in atomic-energy research for simpler, cheaper, and more versatile apparatus for isotopic-separation work. We need apparatus for use with tracer amounts of relatively nonvolatile materials where almost full recovery is possible. Also the apparatus must be safe and decontaminable when used with highly radioactive materials.

REMOTE-CONTROL ENGINEERING

This brings us naturally to the fifth major field of engineering for atomic research, namely, remote-control engineering. This branch is perhaps the nearest of any thus far mentioned to the field of mechanical engineering. It may be the most important single field in the future development of atomic energy. There is hardly any research today involving nuclear science which does not involve remote-control operations to some extent. Perhaps it is a simple operation, such as transferring a radioactive sample from a lead pot to an improvised shielded area by means of a set of long tongs. The activity may not be large, but, if spilled, might enter the human body through a cut, via the air, or orally, and ultimately cause serious radiation damage. Less seriously, the accident might contaminate valuable ap-

paratus and thus slow up or prevent completion of the research. It is obvious that the tongs used for this simple "hot" operation must have properties not required in, say, foundry tongs. Furthermore, the improved lead shield behind which the researcher hopes to be able to do simple radiochemistry must be adequate in two respects; it must be of sufficient extent and thickness to protect the researcher; it must be physically stable.

In this connection, Fig. 2 shows a slide of a conventional "fishtail" lead brick which is used at the present time for building up shielding walls. These bricks do have the following desirable properties: They are interlocking so that when built into a wall (not too high) the wall is relatively stable; they join together so that there are no direct cracks from side to side to let radiation through. On the other hand, such bricks are spoiled easily when dropped because of the feather edges; they are expensive to produce; they do not lend themselves easily to decontamination procedures. I challenge my readers to produce a brick design which will satisfy our needs and yet not have these undesirable features.

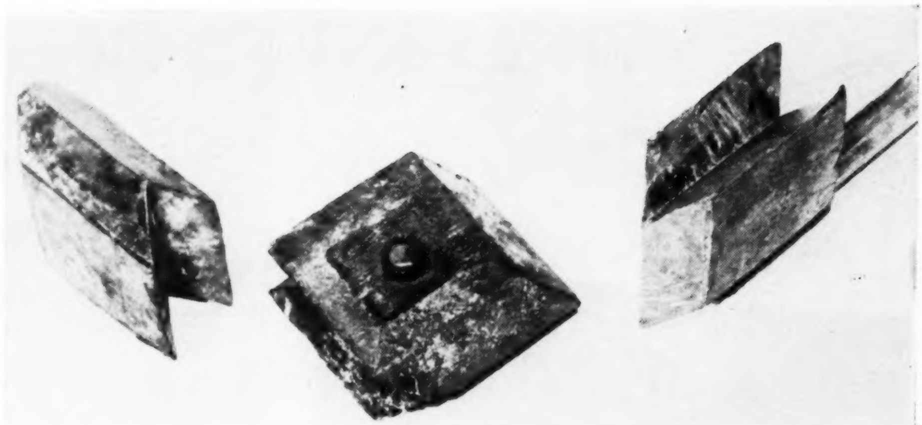


FIG. 2 INTERLOCKING CONSTRUCTION BRICK

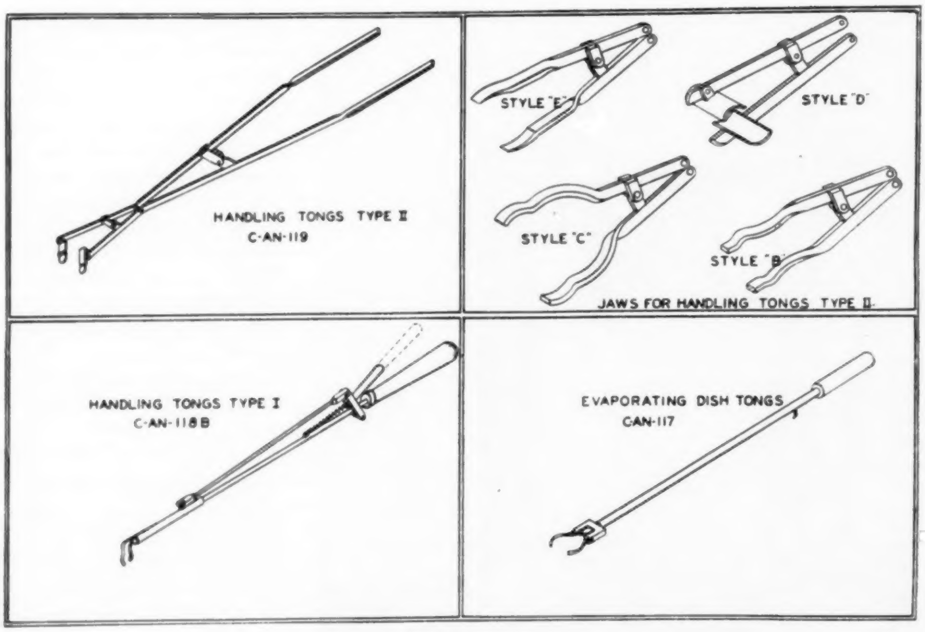


FIG. 3 SEVERAL TYPES OF TONGS

The ultimate design for a building or room in which high levels of radioactivity are to be handled would be a completely enclosed and heavily shielded structure in which many operations could be carried out by remote control. Again we have the problem of performing a large variety of operations through a heavily shielded airtight structure. In addition, one has the problem of viewing operations inside such a structure. No really satisfactory method has as yet been worked out to do this. Television, periscopes, mirrors, high-density transparent solutions—all have been used with varying degrees of success.

Some of the problems of remote-control engineering are illustrated by the remote-control devices or gadgets, Figs. 3 to 6, which research workers with the help of engineers, especially recently, have developed as a result of a definite specific need. I am indebted to Ray Goertz, head of the Remote Control Group at ANL for the use of these illustrations.

No program in the development of remote-control engineering has yet been set up which will even approximate the needs of the research worker in atomic energy now and in the future. Scientists will want to handle ever-increasing amounts of radioactivity and to do ever-increasingly difficult experiments with radioactive materials. The urge to produce an automaton should no longer be for spectacular exhibitions only, but for very practical needs. The speed with which nuclear research goes on will, in the future, depend almost beyond imagination upon the speed in the development of remote-control engineering. Certainly this field is at the present time only in its infancy—if it has really been born.

SHIELDING AND VENTILATION ENGINEERING

The sixth and seventh major fields of engineering in atomic-energy research also involve the handling of radioactive materials. These are shielding and ventilation engineering. Shielding engineering will, of course, play a major role in any use of a nuclear reactor as a mobile power source. There are more prosaic problems. For example, no one really knows just what is required in the way of shielding for a 60-in. cyclotron. Ten feet of concrete is almost certainly enough, but is five? The difference may mean $50,000 to $100,000 in installation cost.

In many cases it is necessary to have shielding which can be moved readily in a small space. What is the best way of mov-

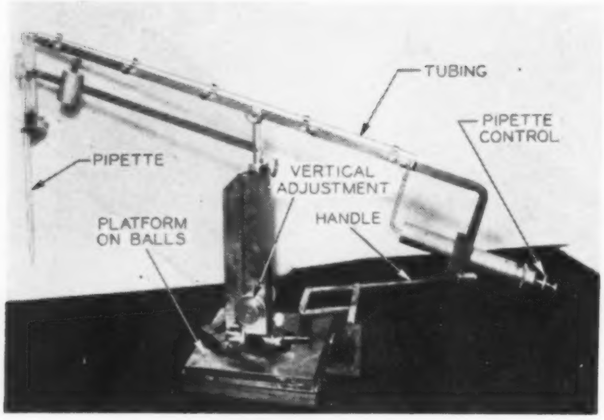


FIG. 4 PANTOGRAPH MANIPULATOR

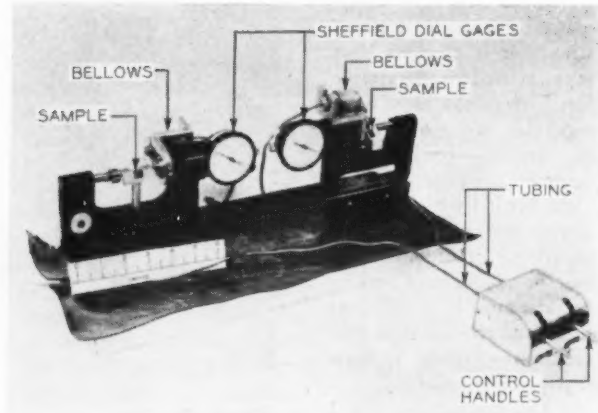


FIG. 6 REMOTE-CONTROL GAGES

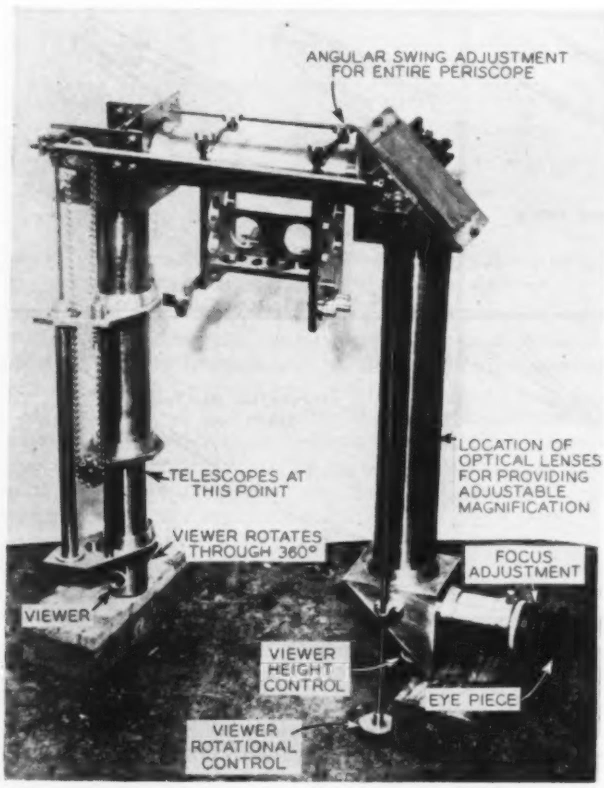


FIG. 5 PERISCOPE

ing a 2-ton block of concrete or lead? Should it be lifted hydraulically out of the way, swung on hinges, or run on tracks? This problem arises again and again, and no method used to date seems really satisfactory.

Similarly the air-conditioning and ventilation equipment for a modest radiochemical laboratory may cost several hundred thousand dollars—and not one cent for the comfort of the researchers. Such expensive installations are required mainly to supply large linear air velocities through the faces of various radiochemical hoods or other special cubicles designed for use with hazardous gaseous or particulate radioactive materials. At the present time there is an imperative need for a more adequate design of radiochemical hood. In a sense such hoods might be called micro hot labs. They are used chiefly as laboratory space where physical and chemical operations are carried out on relatively small amounts of activity. No elaborate shielding is required. Frequently, the test tube, or other container walls, is sufficient, but sometimes interlocking lead bricks are stacked up within the hood as improvised shielding, especially for short-time storage. The hood must be well illuminated and have many transparent walls, doors, and panels. In addition, the space within the hood must be easily accessible to the worker's hands through opened doors, removable panels, or ports. While open at any degree, an approximately constant linear velocity of greater than 100 fpm must stream into the hood in such a way as to prevent sprays, gases, or small particles from emerging into the room. Also small active samples must not be blown away. There are other requirements, but this should give an idea of the difficulties. How would you design such a hood?

MISCELLANEOUS PROBLEMS

Before closing I would like to mention a few other fields of engineering which are of major importance. These are more strictly chemical in nature and perhaps less pertinent to the present discussion. However, they will help to demonstrate how the special nature of atomic-energy research modifies ordinary engineering methods. For example, there is chemical engineering, which now not only must deal with extremely corrosive liquids, but also with great amounts of radioactivity. This intense radioactivity may affect the chemical stability of various solvents and thus introduce problems of "crudding" or gassing, to mention only two.

There is the extremely important problem—important not only to atomic researchers but to every human being—of active waste disposal—sanitation engineering for the atomic age. It is not likely that someone will find the equivalent of an aerobic bacterium which will render active wastes innocuous.

Finally, there are the problems of decontamination of laboratories and apparatus; the development of easily decontaminable surfaces; the use of removable wall and floor coverings. One might add that there will also arise problems of decontamination of personnel, both external and internal. The latter field should probably be classed as medical engineering.

This brief sketch of what seems to me to represent the important fields where engineers are playing and will play highly significant roles in the development of atomic energy will, I hope, serve to emphasize this obvious truth—engineers and research scientists must walk hand in hand with an ever-tighter grip in this age of mountainous research, each fully appreciative of the other's value in bridging the chasms of inexperience.

CONVERSION *of* PIPE LINES *From* OIL *to* GAS TRANSMISSION

The "Big Inch" and "Little Big Inch" Pipe Lines Involved in Major Alteration

By B. D. GOODRICH

CHIEF ENGINEER, TEXAS EASTERN TRANSMISSION CORPORATION, SHREVEPORT, LA.

INTRODUCTION

THE "Big Inch" and "Little Big Inch" pipe lines were constructed by the United States Government during the war at a cost of approximately $146,000,000, according to reports of War Emergency Pipelines, Inc., a nonprofit company which was formed and staffed, at the request of the Government, by a group of oil companies to construct and operate the lines. The Big Inch pipe line was placed in operation in August, 1943, with a designed capacity of 300,000 bbl of crude oil per day. The Little Big Inch pipe line was placed in operation in March, 1944, with a designed capacity of 235,000 bbl of gasoline per day, or a somewhat smaller amount of other petroleum products. The operation of these lines as carriers of petroleum and petroleum products was discontinued in the fall of 1945, after the cessation of hostilities.

In June, 1946, the lines were declared surplus under the Surplus Property Act of 1944, and the War Assets Administration advertied for bids for their disposal stipulating that, "first preference will be given to continuing the Big and Little Big Inch in petroleum service, thereby assuring availability of the lines in the event of a national emergency."

All bids received were rejected by War Assets Administration because "it had become evident that the interest of national defense could be met regardless of whether the pipe lines be used for natural gas, petroleum and its products, or a combination thereof, and (because) bids had been invited on a restricted basis, which precluded the Government securing the maximum net cash return."

New bids were invited by War Assets Administration in December, 1946, with no restrictions as to usage, and the Texas Eastern Transmission Corporation was the successful bidder, expressing in its offer the intention to use the lines primarily for the transportation of natural gas.

There is no question but that in the purchase of these lines we were presented with one of the most unusual problems ever to face a company in the long-distance transmission of gas. We had purchased a line already in place with a definite origin and a definite termination. There was no choice of an area for gas supply and no choice of an area for the market. It was necessary to develop those which existed along or adjacent to these lines. Further, the sizes of the lines were fixed, as was the wall thickness of the pipe, which in turn determined the pressures at which they could be operated. The locations of the pumping stations were established. In other words, it was necessary to develop a gas supply, a market, and a compressor-station design to fit the lines. Usually, some of these are variables in the design of a system. We had no variables except in the location of the compressor stations.

The government had also included in the terms of the sale of the property the National Security Provisions for its recapture in time of emergency by which the purchaser is required to be able to restore the property within 90 days to the same operating conditions, ordinary wear and tear excepted, as existed at the time of the sale.

THE PROPOSED SYSTEM

Fig. 1 shows the Texas Eastern Transmission Corporation system as we propose to operate these properties. At the present time, it is our intention to utilize all of the 24-in. line from Longview, Texas, to the Philadelphia area, and all of the Little Inch line from Beaumont, Texas, to the Philadelphia area for the transportation of natural gas. The property from the Philadelphia area to Linden, N. J., consisting of two 20-in. lines, is being used at the present time for storage purposes to assist in taking care of peak conditions which occur on the systems of our customers on the eastern end of the line.

As a result of the decline of the natural-gas fields which serve the Appalachian area, and the increased growth and demand for natural gas in this region, the Appalachian area presented us with an attractive market. The major gas-distribution companies operating in this territory were anxious to augment their gas supply as their requirements were so great and the supply so short that a very critical condition existed. The metropolitan Philadelphia area has also had a tremendous growth and a resulting demand for fuel gas. To meet this demand, new plants were required to be built at great cost. However, by obtaining a supply of natural gas for reforming and enriching the manufactured gas, the new construction would not be necessary and the fuel requirements could be met at a much earlier date. Successful negotiations resulted in plans for the delivery of natural gas to this area by the fall of 1948.

For our gas supply, it was necessary to obtain reserves as close as possible to the lines, since pipe was and still is difficult to obtain. We were fortunate that the location of the 24-in. line lay close to several fields in northeastern Texas which did not have an outlet for their gas and also within 45 miles of the great Carthage Field in Panola County, Texas. From this area, we were able to obtain a sufficient quantity of gas to load the 24-in. line to capacity. The Little Inch line running north and south most of the way through the western portion of Louisiana passes within a short distance of several major fields, some of which did not have gas outlets. The feeder system for the Little Inch line running from Beaumont west to the Houston, Texas City area, also was adjacent to many small fields. Hence

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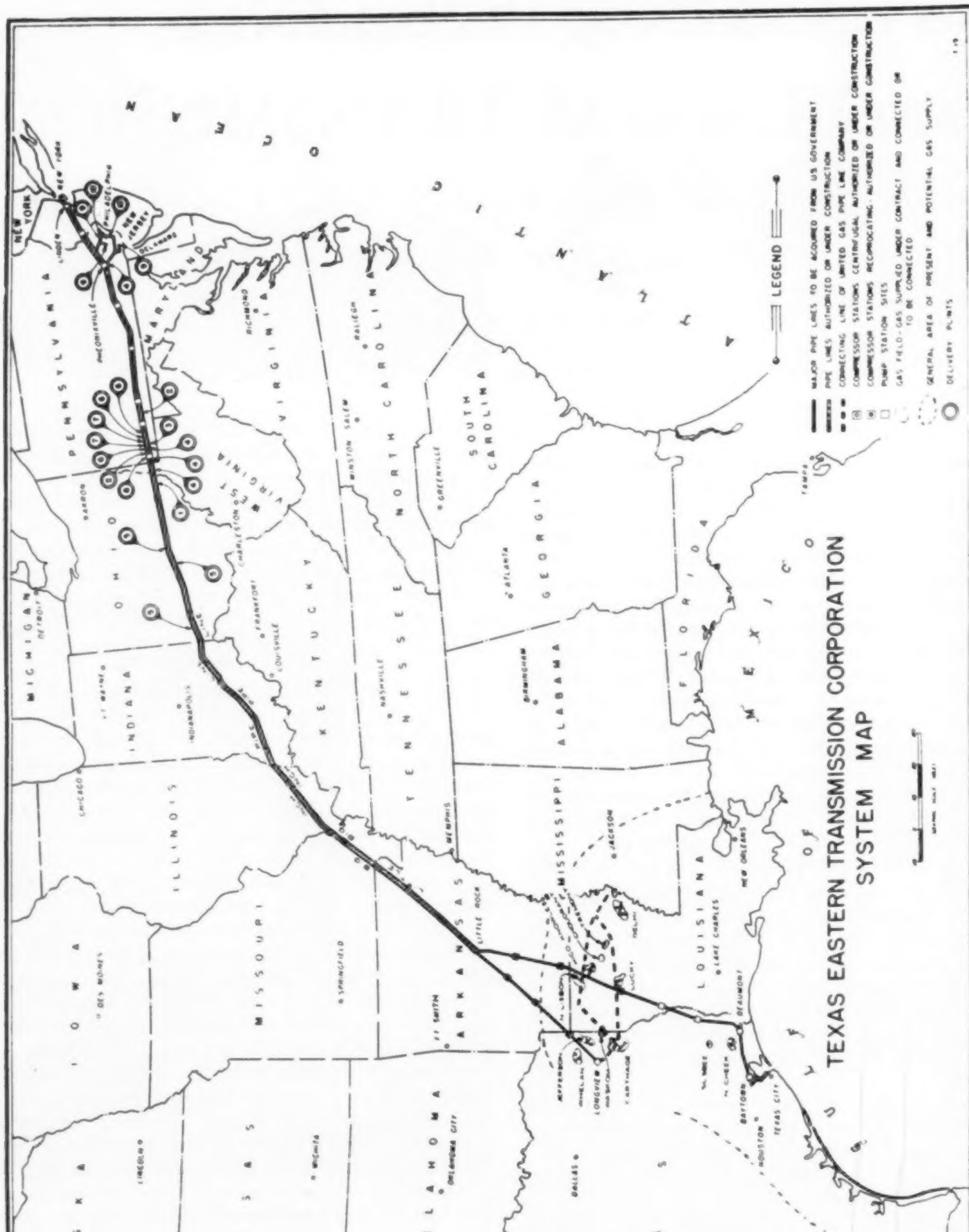

FIG. 1 SYSTEM MAP OF TEXAS EASTERN TRANSMISSION CORPORATION

we were able to provide an outlet for gas from these locations. Perhaps we would not have chosen all of the present sources of gas if the complete design of the system had been available to us, but it was fortunate that the sources of supply were so advantageously located with respect to our lines. Furthermore, it is fortunate that circumstances allowed us to provide an outlet for natural-gas fields which otherwise might not have been developed.

PIPE-LINE CHARACTERISTICS

The Big Inch main line runs from Longview, Texas, to Linden, N. J., a distance of 1340 miles. The Little Big Inch originates near Beaumont, Texas, and terminates at Linden, N. J., a distance of 1479 miles. The 24-in. line consists of $^3/_8$-in-wall pipe and is seamless. The 20-in. line is primarily composed of $^5/_{16}$-in-wall pipe and is essentially all electric-weld pipe. The allowable safe design working pressure for natural gas for both lines is 790 psig. Some difficulty was experienced by the WEP in obtaining this pressure when testing the 20-in. line, and the maximum test pressure was then limited to 750 psig. We decided to operate the lines from Little Rock, north, as a looped system, thus establishing the working pressure of the 20-in. line as that for the whole system. We were further restricted as to maximum working pressure, by the fittings and valves originally installed which were all for 800 psig and the majority were of cast iron.

With the operating pressure established, studies were begun to determine the quantity of gas that could be transported economically through the lines. All of the original studies were based upon the use of gas-engine-driven compressors, and a station spacing irrespective of the existing pump-station sites. These studies determined that the best operation should be with a delivery of 420,000 to 450,000 M cu ft.

ELECTRIC-DRIVE CENTRIFUGAL COMPRESSOR STUDIED

In April, 1947, inquiries were made of the engine manufacturers to determine whether engines could be obtained and their approximate delivery dates. Out of these discussions came a proposal to build a centrifugal compressor using an electric drive. This was very interesting, and immediately appealed to us because of the increased possibilities it presented the better to utilize the facilities which were being purchased. The management asked for an immediate investigation into the practicability of using centrifugal compressors. All of the available published information was assembled and studied.

Discussions were held with the equipment manufacturers and from these investigations, it was developed that:

1 Centrifugal compressors had not been used for pressures above 500 psig.

2 They had not been used for long gas-transmission lines.

3 There was some question as to the ability to obtain a satisfactory seal for this service and these pressures.

4 Considerable progress had been made in their design during the war, both in the techniques of their manufacture and the materials that go into their construction.

5 First cost of the compressor and motor was in line with other compressing equipment.

6 Maintenance and operating costs other than fuel were estimated to be considerably less than for gas engines.

7 The centrifugal compressor is essentially a high-capacity machine.

Management was advised of the known limitations of this equipment, none of which appeared to be incapable of solution. Economic studies further developed that by using the centrifugals more gas actually could be delivered to the market, since no gas for fuel would be required, and the price we could afford to pay for the electric power was in the range of that which the WEP had paid, during the operation of the line for oil service.

The hardest part of the decision to use centrifugal compressors was the break with tradition. As always, we would rather someone else would try it first. But management had the courage, whether by wisdom or necessity, to break away from tradition and trust the engineers, designers, and manufacturers to produce the equipment that would perhaps revolutionize the transportation of natural gas. This decision was made in April, 1947.

It was necessary to work very closely with the equipment manufacturers during the early stages of development and planning so that we could learn as much as possible about these new machines, particularly the operating characteristics so that the flow design for the pipe lines might continue.

COMPRESSOR DESIGN PROBLEMS

One of the first decisions made was to design the compressors to fit the foundations and piping in the pump houses on the former 24-in. crude line and 20-in. products line. In other words, we proposed to take the oil pump out of service and replace it with a compressor for gas service. This arrangement established the physical design of the compressors, calling for a double-suction unit, similar in appearance to the liquid pumps that they were to replace. A second major decision was to establish the speed of the compressors at 3600 rpm. This meant that we could utilize all of the electric motors from the products line as direct-connected prime movers for the compressors. They are 1250-hp, 3600-rpm, 2300-volt squirrel-cage induction motors. The motors from the crude line could not be so easily adapted since their rated speed is 1750 rpm, and thus would require a speed-increasing gear. At the present time these motors are not being utilized.

With the physical appearance and speed of the machine established, the next step was the size or capacity. This was limited by the horsepower of the existing motors which we proposed to utilize.

Our flow studies, using reciprocating engines, had developed that a compression ratio of approximately 1.3 would exist with spacing of the stations approximately 50 miles apart and passing approximately 425,000 M cu ft per day at 15.025 lb pressure base. With this ratio in mind, it was further determined that it could be developed by using 3 stages of compression, with the centrifugal equipment. The design capacity of the compressors was then established as 225,000 M cu ft through a compression ratio of 1.3 in 3 stages. Other design conditions were inlet temperatures of 60 F, specific gravity of 0.60, discharge pressure of 750 psig, and an N and K value for the gas of 1.27.

By operating the crude and products pump stations in parallel, the capacity of the six single-stage centrifugal compressors is approximately 450,000 M cu ft per day at the design conditions.

The manufacturers began their work on the detail design of the machines in May, 1947. Texas Eastern began operation of the line under a lease arrangement with the War Assets Administration on May 1, 1947. Natural gas was introduced into the lines at 750 to 800 lb pressure and, without compression, delivered approximately 140,000 M cu ft daily to the Appalachian area.

The capacity of the system was established at approximately 450,000 M cu ft daily, representing 433,000 M cu ft actual sales and the remainder for fuel, loss, and unaccounted gas. The centrifugal compressor, electrically driven as proposed, lacked one very important feature and that was variability in capacity,

speed, and compression ratio. These were all fixed. The only means of changing the operation was by shutting down one stage or by throttling with the suction valves, neither of which is very desirable. To offset this lack of ability to meet changing flow conditions, several reciprocating stations were included in the final design of the system, spaced strategically to best make the system as a whole capable of meeting varying conditions of flow. A total of 36,000 hp will be installed in five of these reciprocating stations. Some of these stations have stand-by engines, and all of the compressor cylinders have variable clearances to adapt them better to a wide range of flow and pressure conditions. The system is designed to maintain as close as possible a 750-psig discharge from all stations.

ARRANGEMENT OF COMPRESSOR STATIONS

The design of the centrifugal stations was initiated with the primary aim of utilizing as much as possible of the existing

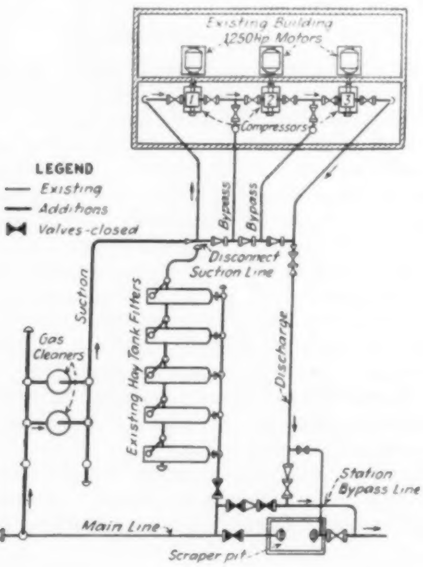

FIG. 2 TYPICAL COMPRESSOR-STATION LAYOUT UTILIZING CENTRIFUGAL COMPRESSORS

building, piping, and equipment as could be included conveniently and economically in the operation of the station for gas service. Fig. 2 indicates to what extent this was possible. In fact about the only things that are not being utilized are the oil pumps. The chart indicates also that the strainers on the former products stations are not being used; instead we have installed conventional gas scrubbers of the liquid type as a protection for the compression equipment. The only major piping not being utilized is the former inlet from the main line to the pumps. A new suction line has been installed to the inlet of the first compressor. All other major piping including manifolds around the pumps and discharge back into the main line are being used essentially as for oil service and with the addition of no valves or check valves except on the new suction line and at the scrubbers. Most of the miscellaneous small piping and tanks have been put to some new service. The former sump or drain tanks are now used as storage reservoirs for the oil used in the scrubbers or as a blowdown or drain from the scrubber. The former slop tank on the products line is being utilized as water storage for the cooling system.

ELECTRICAL SYSTEM

The electrical system, one of the major facilities at each station, is being utilized completely and in a similar manner as for oil service. The existence of these electrical facilities was a very important factor in the decision to use the centrifugal compressors with electric drive. Other buildings at the stations are being used for storage or office use in much the same manner as the War Emergency Pipelines, Inc., used them. Few new structures will be built except a new warehouse for storing the oil pumps and motors from the oil lines. The new warehouse will give complete protection for this equipment, thus assuring the best possible maintenance for it.

Because of the National Security Provisions in the purchase agreement, which require "that the property shall be restored to use as an oil carrier within 90 days," it was advisable to make as few changes as possible in the piping and electrical facilities. Most of the changes, which have been made or will be made in the property, consist of the transfer of motors, switchgear, transformers, and large valves from stations not being used for gas transmission to those stations which we propose to convert.

At those stations where reciprocating equipment is being installed, no changes at all are being made which will affect the use of the former oil stations for re-use in that service. Here, completely new buildings and equipment are being installed. The idle pump stations will remain in the state of protective maintenance to which they were so effectively and excellently retired by the War Emergency Pipelines, Inc., during the latter part of 1945. The maintenance program initiated at that time will be continued for all of this equipment.

Major additions proposed for the system other than the stations, contemplate the looping of river crossings as insurance against losing any of them, and the installation of main-line gate valves throughout the system. Due to shortage in materials existing at the time these lines were constructed few valves were installed between stations, and it is considered to be good practice on gas-transmission lines to have a valve every 12 to 17 miles.

Both lines were received in very good condition and extensive cleaning, purging, and repairs have not yet been necessary.

Two stations using the centrifugal compressors were placed in operation during the month of November, 1947, and their performance has been substantially as predicted up to the present time. Extensive field tests of the first units were conducted at the Little Rock station during the month of October, 1947. These tests indicated that the manufacturers had done an excellent job on the compressor unit itself, although some changes were dictated both in the compressor and in the auxiliary equipment. These improvements and changes have been made and there are now six stations in continuous operation.

Less than one year after taking possession of the property, Texas Eastern is delivering more than 300,000 M cu ft (March, 1948), of natural gas to areas where critical fuel shortages exist. Only by the use of centrifugal compressors, could this have been accomplished. Construction is continuing on additional installations which will further increase the capacity to 433,000 M cu ft by October, 1948. A total of 16 stations utilizing centrifugal compressors and requiring an installed horsepower of 117,500 will be constructed.

On February 16, 1948, an application was filed with the Federal Power Commission asking for authority to increase the capacity of the system to 508,000 M cu ft of sales per day. This will be accomplished by additional compressors at both reciprocating and centrifugal stations throughout the system and will not require any looping or new stations.

The electrical industry has watched this development very carefully and has been most helpful to us in making the progress which has been achieved. Power shortages prevailed in many areas during the fall and winter of 1947 and will continue

throughout 1948. Through interconnections of various systems, the power companies are able to provide the power required for this operation even though many of these companies have already sold the capacity which had been used for the operation of these stations during the war.

DETAILS OF COMPRESSOR UNITS

The centrifugal compressor, as installed in our stations, is a simple machine in appearance and contains only a fraction of the number of separate parts which are contained in a reciprocating machine of equivalent capacity. The major parts are (1) case, upper and lower; (2) prerotation vanes; (3) shaft complete with rotor or impeller; (4) inboard and outboard bearing assemblies; (5) thrust bearing; (6) oil system for bearings; (7) shaft-sealing units. These parts are indicated on the cross-section of the machine, Fig. 3. The last of these major parts is the most important. All of the others have been used in essentially the same form, either in liquid pumps or in low-pressure air or gas compressors for some time.

The seal is the heart of the compressor. It is a mechanical seal of the hydraulic type, consisting of three principal parts; namely, a rotating ring and two stationary sleeves which provide the surface contact for the rotating ring. Oil at a pressure higher than that of the gas being compressed maintains these sleeves in proper contact with the ring, and any oil leaking across these faces is fully recoverable. The oil also provides a cooling medium for the seals. Each compressor has its own seal oil system with stand-by units and protective devices in

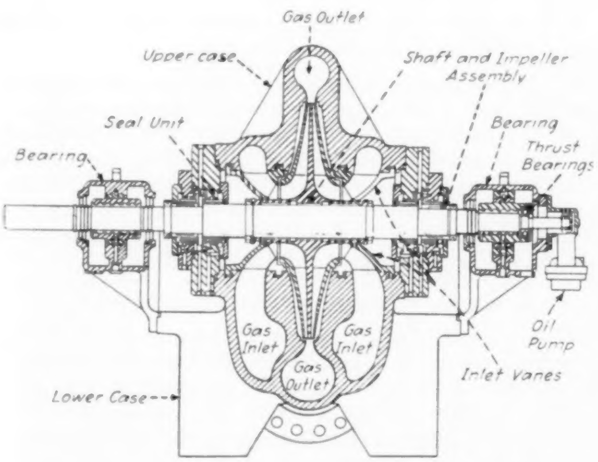

FIG. 3 CROSS-SECTION OF CENTRIFUGAL COMPRESSOR

case of failures of any kind to the oil system, electrical system, or to the compressor unit.

Push-button operation of the compressors is provided. In starting a unit, a push button opens the discharge valve, a second button starts the motor. When up to speed, a third button opens the suction valve to load the machine. Other buttons are used to start the oil pumps on the bearing and seal oil system. These controls are mounted on a central panel so located that all of the machinery is in view of the operator.

Maintenance of a unit is expected to be very small. There is nothing much to wear or get out of order. A complete overhaul, that is, dismantling the compressor completely, and replacing with all new wearing parts can be done in less than 8 hr. The life of the sealing unit has not been determined yet, but there is no reason to expect that it will not last as long as the bearings on the shaft.

The compressor lends itself to prime movers other than the electric motor, particularly the steam turbine and, perhaps in the not too distant future, the gas turbine.

COMPRESSOR OPERATING CHARACTERISTICS

Characteristic curves for a single-stage machine as developed from field tests are indicated in Fig. 4. The discharge pressure is constant over a wide range of capacities for a given suction pressure. Power requirements are a function of suction pres-

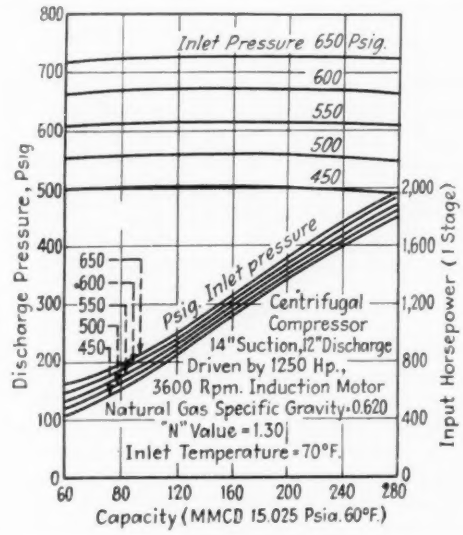

FIG. 4 CENTRIFUGAL COMPRESSOR PRESSURE-VOLUME-POWER CHARACTERISTICS, ONE-STAGE OPERATION

sure and capacity and as indicated by the slope of the curve, a fairly constant relationship exists. This test performance includes plug valves on the inlet and outlet of the compressor. We have not yet been able to isolate the performance of the machine itself.

Our units have been operated in every possible combination from two units in parallel to six units in series. No serious difficulties have been experienced. However, we have had our share of minor troubles. Operation in parallel is very sensitive at low capacities. In building up the capacity of the lines, it has been necessary to operate the centrifugal compressors for a time at less than 50 per cent of design capacity. But good performance has also been experienced, with one of our stations, operating during the month of January and February, 1948, at better than 90 per cent electric load factor.

Undoubtedly, there will be further changes and modifications in the equipment as continued operation reveals more of the characteristics and possible weaknesses, but much progress has been made in the past year.

CONCLUSION

The conversion of these lines to natural gas adds yet another chapter to their historic existence which began in 1942. The role which they played in the winning of the war by the transportation of great quantities of petroleum and petroleum products from the Southwest to the eastern refineries and terminals is well known. The role which they are undertaking now will probably not be known to such a large group of the public, but it will be one just as grateful, for they will be carrying relief, this time to a people facing a critical fuel shortage, and perhaps later to areas and people who have never known the advantages of natural gas. Thus, the Big Inch and Little Big Inch, like so many other industries, have turned from a wartime creation and use, to find their place in peace.

STRAIGHT-SIDED SPLINES

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THE SAE Standard for Straight Sided Splines gives the formulas and dimensions for fittings only for three depths of keyway. This paper proposes a set of tolerances and allowances for both the male and female members for five "classes" of fit: namely, free fit, sliding fit, push fit, light drive fit, and press fit for each of three "types" of fit—minor-diameter fit, key fit, and major-diameter fit, based upon the medium depth of keyway of the SAE Standard.

EARLY MULTIPLE-SPLINE FITTINGS

In the early days of the automobile, the Society of Automotive Engineers developed a standard for multiple-spline fittings having 4, 6, 10, and 16 splines. This standard was intended for soft broached holes in fittings; no dimensions were given for the mating shaft part. The outside shaft diameter was the nominal diameter. By varying the inside diameter of the hole, three different depths of keyway were obtained. The most shallow keyway was designated for parts with a "permanent fit," medium keyway for parts "to slide when not under load," and the deepest keyway for parts "to slide when under load." These three keyway depths applied only to the 6, 10, and 16-spline fittings, the 4-spline fitting having only two keyway depths, shallow and medium, for parts with a "permanent fit," and "to slide when not under load," respectively.

This standard has formed the basis quite generally for multiple-splined shafts and fittings used in industry, but various companies have made certain modifications. Some variations of these standards have been based upon the minor diameter as the nominal diameter, others have used different spline widths, and still others have changed the height of the key. A survey of industry, particularly machine-tool manufacturers, indicated that in the majority of cases the manufacturer had standardized on the medium-height key and was not using the shallow key—"permanent fit," or the deep key—"to slide when under load."

DEVELOPING A NEW STANDARD

A few years ago, the Spline Committee, Technical Committee 13 of the American Standards Association, Sectional Committee B5 of Small Tools and Machine Tool Elements, appointed Subgroup II on Straight Splines to formulate a standard to adapt the Society of Automotive Engineers' standard for the use of machine-tool and general-machinery manufacturers. It was decided to base the new tentative standard on the outside shaft diameter as the nominal diameter, and to confine the standard to only one key height, the height designated to "slide when not under load" in the Society of Automotive Engineers' standard.

There can be three "types" of fit between the shaft and fitting: on the minor diameter, on the sides of the keys, or on the major diameter. These three types of fit for a $1^1/_2$-in. nominal diameter are shown in Fig. 1, together with the five "classes" of fit for each type. The five "classes" of fit are (1) free fit, (2) sliding fit, (3) push fit, (4) light drive fit, and (5) press fit.

Experience indicates that these five "classes" of fit are necessary to meet all the major requirements of general machine design as follows:

1 Free fit is desirable for long shafts where the sliding member is supported independently of the shaft; where the shaft transmits torque alone.

2 Sliding fits may be used for such elements as sliding gears, clutches, etc.

3 Push fit is used for parts which must be taken apart after assembly.

4 Light drive fit is suitable for parts which are disassembled only in case of breakage or major maintenance.

5 Press fit is used for the permanent assembly of solid shafts to parts with heavy hubs.

The 4-spline fittings of the Society of Automotive Engineers' standard have seldom been used in machine-tool or general-machinery design, and for this reason have been dropped from the new tentative standard. It is intended to use only the 6, 10, and 16-spline fittings with diameters from $^3/_4$ in. to 6 in. Shaft sizes will vary in increments of $^1/_8$ in. from $^3/_4$ in. to 2 in. nominal diameter, increments of $^1/_4$ in. from 2 in. to 4 in., and in $^1/_2$-in. increments from 4 in. to 6 in.

REQUIREMENTS OF MACHINE-TOOL INDUSTRY

In the machine-tool industry a majority of the shafts and parts having spline fittings are hardened so as to be unmachinable except by grinding. Because the minor-diameter fit is the only one of the three fits in which the two mating surfaces can be ground economically, this type of fit has become firmly established in the machine-tool industry. One major objection to this type of fit is the looseness between the side of the key and the keyway; this is a source of backlash in a train of gears and clutches. Where necessary this condition can be somewhat mitigated by increasing the width of the key, thus decreasing the clearance at the sides of the key and approaching the key type of fit.

In instances where a part such as a gear fitted to a shaft with the hub of the gear either soft or heat-treated only to a hardness where the hole can be finish-broached after hardening, then the key type of fit can be used and may prove very desirable. There are few applications which require the major-diameter fit, i.e., where it has definite advantages over the minor-diameter fit or the key fit. In the opinion of the author, for conditions which do not call for a minor-diameter fit (where it is not necessary to have the two mating surfaces ground), the involute spline is a better design and more economical.

Referring again to Fig. 1, it will be noted that the keyway width is kept the same for all three types of fit. This permits

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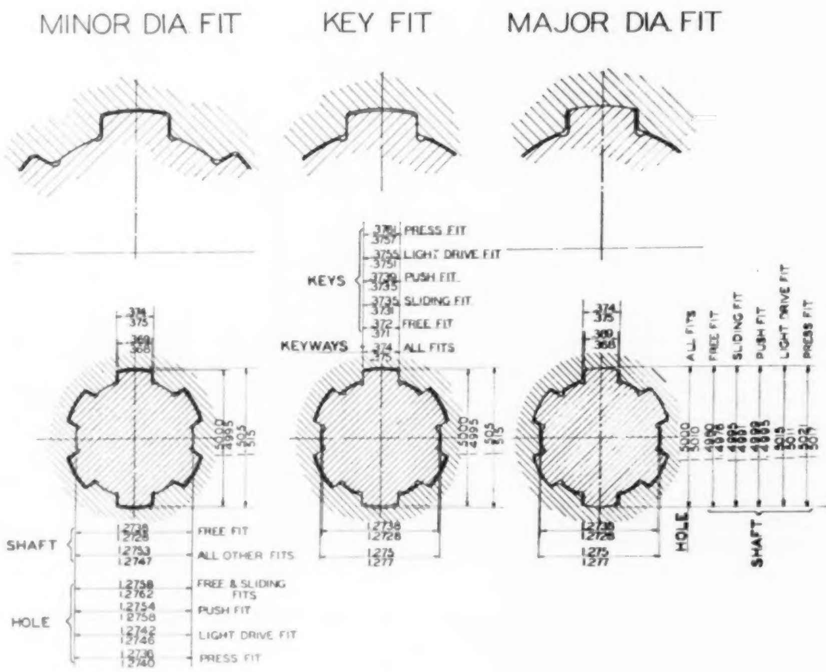
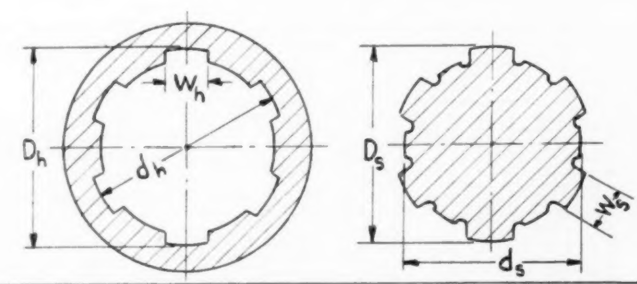


FIG. 1 THE 5 CLASSES OF FIT FOR EACH OF THE 3 TYPES OF FIT FOR A $1\frac{1}{2}$-IN. NOMINAL-DIAMETER SHAFT AND FITTING

Minor Dia. Fit 6 Spline
1 - Free
2 - Sliding Fit
3 - Push Fit
4 - Light Drive Fit
5 - Press Fit



Nomin. Dia.	D_h	d_h 1 & 2	d_h 3	d_h 4	d_h 5	W_h	D_s	d_s 1	d_s 2,3,4,5	W_s 1	W_s 2,3,4,5
.750	.755	.6380	.6378	.6369	.6364	.186	.7500	.6362	.6377	.183	.184
	.765	.6383	.6381	.6372	.6367	.188	.7495	.6354	.6373	.181	.183
.875	.880	.7443	.7441	.7432	.7427	.217	.8750	.7425	.7440	.214	.215
	.890	.7446	.7444	.7435	.7430	.219	.8745	.7417	.7436	.212	.214
1.000	1.005	.8505	.8503	.8494	.8489	.248	1.0000	.8487	.8502	.244	.245
	1.015	.8508	.8506	.8497	.8492	.250	.9995	.8479	.8498	.242	.244
1.125	1.130	.9569	.9566	.9555	.9549	.279	1.1250	.9550	.9565	.275	.276
	1.140	.9573	.9570	.9559	.9553	.281	1.1245	.9541	.9560	.273	.275
1.250	1.255	1.0631	1.0628	1.0617	1.0611	.311	1.2500	1.0612	1.0627	.307	.308
	1.265	1.0635	1.0632	1.0621	1.0615	.313	1.2495	1.0603	1.0622	.305	.307
1.375	1.380	1.1694	1.1691	1.1680	1.1674	.342	1.3750	1.1675	1.1690	.338	.339
	1.390	1.1698	1.1695	1.1684	1.1678	.344	1.3745	1.1666	1.1685	.336	.338
1.500	1.505	1.2758	1.2754	1.2742	1.2736	.373	1.5000	1.2738	1.2753	.368	.369
	1.515	1.2762	1.2758	1.2746	1.2740	.375	1.4995	1.2728	1.2747	.366	.368
1.625	1.630	1.3821	1.3817	1.3805	1.3799	.404	1.6250	1.3801	1.3816	.399	.400
	1.640	1.3825	1.3821	1.3809	1.3803	.406	1.6245	1.3791	1.3810	.397	.398
1.750	1.755	1.4883	1.4879	1.4867	1.4861			1.4863	1.4878	.431	.432
	1.765	1.4887	1.4883	1.4871							
	1.880	1.5946									

FIG. 2 PORTION OF A TABLE OF DIMENSIONS FOR 6-SPLINE MINOR-DIAMETER FIT

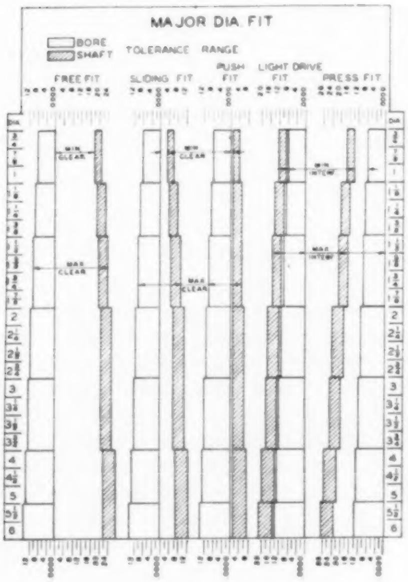


FIG. 3 DIAMETER TOLERANCES FOR MINOR-DIAMETER FIT

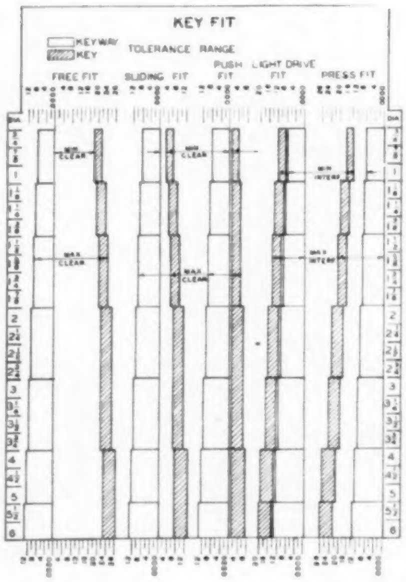


FIG. 4 KEYWAY TOLERANCES FOR KEY FIT

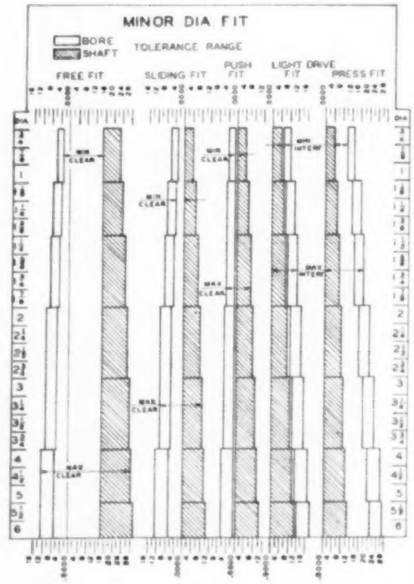


FIG. 5 DIAMETER TOLERANCES FOR MAJOR-DIAMETER FIT

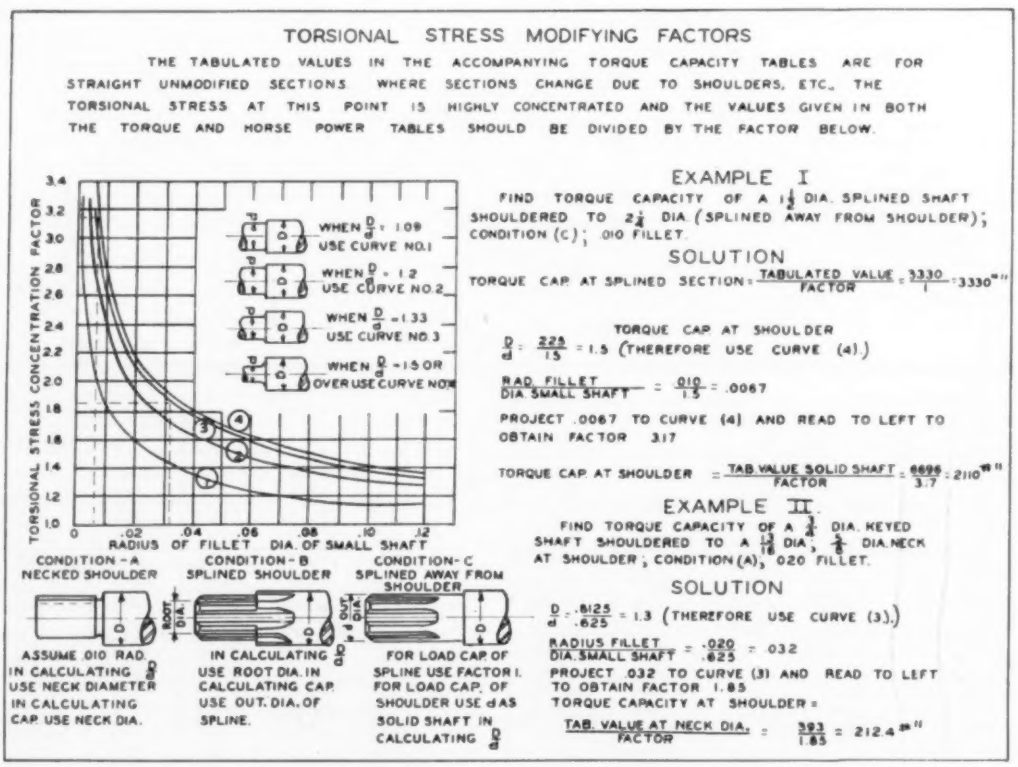


FIG. 6 TORSIONAL-STRESS MODIFYING FACTOR FOR SHAFTS WITH SHOULDER

the same broach to be used for both the minor-diameter type and key type of fit. If necessary the same broach can also be used for the major-diameter type of fit by grinding down the outside diameter of the broach. Hobs are less expensive than broaches, so a different hob is used for each type of fit. If only a few pieces of a type are to be made, a cutter can be ground to suit, and the splines can be milled in the shaft instead of being hobbed.

WORKING DATA

A part of a table of dimensions for the five classes of fit for the minor-diameter type of fit is shown in Fig. 2. The same

TORQUE CAPACITY IN POUND-INCHES (POUNDS AT 1" RAD.)
BASIS 10000 POUNDS PER SQUARE INCH
FOR OTHER STRESSES, VALUES BELOW ARE DIRECTLY PROPORTIONAL

OUT DIA. IN D	HOLLOW SHAFTS — WALL THICKNESS IN DECIMALS OF AN INCH .035	.049	.065	.095	.120	.134	.156	.188	.250	.313	.375	.500	.625	SOLID SHAFT	B = 1/4 D, d = 1/2 B	K&T STD.
1/2	111	143	172	210										248	202	
5/8	182	236	289	367										484	393	
3/4	268	352	441	568	651	685	730	775						836	680	431
7/8	371	499	625	821	952	1012	1091	1175						1320	1072	685
1	496	667	842	1122	1308	1404	1524	1688	1848					1980	1608	1020
1 1/8	630	854	1085	1464	1728	1848	2035	2250	2532					2820	2291	1451
1 1/4	796	1070	1368	1858	2208	2375	2628	2928	3348	3600	3744			3876	3149	1995
1 3/8	959	1303	1674	2295	2736	2965	3276	3708	4272	4656	4896			5148	4182	2651
1 1/2	1154	1572	2022	2784	3360	3612	4032	4536	5328	5868	6216	6552		6696	5440	3440
1 5/8			2309	3300	3985	4455	4850	5482	6500	7225	7700	8220		8447	6865	4375
1 3/4			2808	3900	4692	5124	5748	6540	7800	8748	9420	10200		10620	8630	5475
2			3744	5220	6300	6888	7740	8880	10764	12240	13340	14760	15430	15840	12870	8150
2 1/4			4716	6648	8136	8916	10056	11640	14170	16270	17960	20240	21504	22560	18330	11620
2 1/2			5904	8268	10620	11250	12740	14720	18190	21050	23380	26730	28780	30960	25150	15825
2 3/4			7296	10230	12530	13812	15740	18180	22620	26340	29490	34240	37270	41220	33480	21260
3			8664	12265	15080	16595	18960	21975	27550	32280	36370	42650	47020	53500	43460	27560
3 1/4			10160	14470	17855	19560	22520	26160	32880	39000	43910	52020	57840	68160	55380	34900
3 1/2			11240	16875	21600	22920	26420	30910	38800	46150	52320	62400	70210	85020	69200	43710
3 3/4								35430	45140	53580	61150	73680	83160	104640	84950	53450
4								40800	52130	61950	71100	86080	97850	126960	103150	65300
4 1/4									59700	71040	81480	99300	113350	151900	123400	78200
4 1/2									67320	80880	93180	113650	130550	180500	146600	93350
4 3/4									75780	91080	104700	129150	148700	212400	172500	109600
5									84600	101520	117720	145250	168500	247900	201400	127500

SIZES BELOW ZIG-ZAG LINE ARE SUBJECT TO BUCKLE AND SHOULD BE AVOIDED

FIG. 7 HORSEPOWER CAPACITY OF SHAFTS

HORSE POWER PER 100 R.P.M.
BASIS 10000 POUNDS PER SQUARE INCH.
FOR OTHER STRESSES VALUES BELOW ARE DIRECTLY PROPORTIONAL

OUT DIA. IN. D	HOLLOW SHAFTS — WALL THICKNESS IN DECIMALS OF AN INCH .035	.049	.065	.095	.120	.134	.156	.188	.250	.313	.375	.500	.625	SOLID SHAFT	B: 1/4 D, d: 1/2 B	K&T STD.
1/2	.177	.227	.272	.333										.394	.320	
5/8	.290	.375	.459	.58									—	.78	.624	
3/4	.425	.56	.70	.90	1.03	1.09	1.16	1.23						1.33	1.08	.68
7/8	.59	.79	.99	1.30	1.51	1.60	1.73	1.86						2.10	1.70	1.09
1	.79	1.06	1.34	1.78	2.08	2.23	2.42	2.65	2.93					3.14	2.55	1.62
1 1/8	1.00	1.36	1.72	2.32	2.74	2.95	3.23	3.57	4.02					4.48	3.64	2.30
1 1/4	1.26	1.70	2.17	2.95	3.50	3.77	4.17	4.65	5.31	5.7	6.0			6.1	5.00	3.17
1 3/8	1.52	2.07	2.65	3.64	4.34	4.70	5.20	6.0	6.8	7.4	7.8			8.2	6.6	4.21
1 1/2	1.83	2.50	3.21	4.42	5.33	5.74	6.40	7.2	8.5	9.3	9.9	10.4		10.6	8.6	5.46
1 5/8			3.66	5.24	6.32	7.07	7.70	8.7	10.3	11.5	12.3	13.0		13.4	10.9	6.94
1 3/4			4.46	6.20	7.5	8.1	9.1	10.4	12.4	13.9	15.0	16.2		16.9	14.0	8.7
2			5.94	8.30	10.0	10.9	12.3	14.1	17.1	19.4	21.2	23.4	24.5	25.2	20.	12.9
2 1/4			7.5	10.5	12.9	14.2	16.0	18.5	22.5	25.8	28.5	32.1	34.1	35.8	30.	18.4
2 1/2			9.4	13.1	16.9	17.9	20.2	23.3	28.9	33.3	37.1	42.4	45.7	49.2	40.	25.1
2 3/4			11.6	16.2	19.9	22.0	25.0	28.8	35.9	41.8	46.8	54.	59.	66.	53.	33.7
3			13.8	19.5	24.0	26.4	30.1	34.9	43.7	51.2	58.	68.	75.	85.	69.	43.7
3 1/4			16.1	23.0	28.4	31.0	35.7	41.5	52.2	62.	70.	83.	92.	108.	88.	55.4
3 1/2			17.9	26.8	33.0	36.4	42.3	49.1	61.6	73.	83.	99.	111.	135.	110.	69.4
3 3/4								56.0	72.	85.	97.	117.	132.	166.	135.	84.8
4								65.0	82.	98.	113.	137.	155.	202.	164.	103.5
4 1/4									95.	113.	129.	157.	180.	241.	196.	124.
4 1/2									107.	128.	148.	180.	207.	287.	233.	148.
4 3/4									120.	144.	166.	210.	236.	337.	274.	174.
5									134.	161.	187.	230.	267.	393.	320.	202.

SIZES BELOW ZIG-ZAG LINE ARE SUBJECT TO BUCKLE AND SHOULD BE AVOIDED.

FIG. 8 TORQUE CAPACITY OF SHAFTS IN POUND-INCHES

TORSIONAL DEFLECTION IN RADIANS PER INCH OF LENGTH
ALSO INCHES DEFLECTION AT ONE INCH RADIUS
BASIS 10,000 POUNDS PER SQUARE INCH.
FOR OTHER STRESSES AND LENGTHS VALUES BELOW ARE DIRECTLY PROPORTIONAL

OUT DIA. IN. D	HOLLOW SHAFTS — WALL THICKNESS IN DECIMALS OF AN INCH.													SOLID SHAFT	B=1/4D d=1/2B	K&T STD.
	.035	.049	.065	.095	.120	.134	.156	.188	.250	.313	.375	.500	.625			
1/2	.00337	.00337	.00337	.00337										.00337	.00405	
5/8	.00285	.00285	.00285	.00285										.00285	.00318	
3/4	.00224	.00224	.00224	.00224	.00224	.00224	.00224	.00224						.00224	.00266	.00208
7/8	.00191	.00191	.00191	.00191	.00191	.00191	.00191	.00191						.00191	.00227	.00179
1	.00168	.00168	.00168	.00168	.00168	.00168	.00168	.00168	.00168					.00168	.00200	.00157
1 1/8	.00151	.00151	.00151	.00151	.00151	.00151	.00151	.00151	.00151					.00151	.00179	.00139
1 1/4	.00135	.00135	.00135	.00135	.00135	.00135	.00135	.00135	.00135	.00135	.00135			.00135	.00161	.00126
1 3/8	.00122	.00122	.00122	.00122	.00122	.00122	.00122	.00122	.00122	.00122	.00122			.00122	.00145	.00114
1 1/2	.00112	.00112	.00112	.00112	.00112	.00112	.00112	.00112	.00112	.00112	.00112	.00112		.00112	.00134	.00105
1 5/8	.00103	.00103	.00103	.00103	.00103	.00103	.00103	.00103	.00103	.00103	.00103	.00103		.00103	.00122	.00096
1 3/4			.00096	.00096	.00096	.00096	.00096	.00096	.00096	.00096	.00096	.00096		.00096	.00114	.00092
2			.00084	.00084	.00084	.00084	.00084	.00084	.00084	.00084	.00084	.00084	.00084	.00084	.00100	.00079
2 1/4			.00075	.00075	.00075	.00075	.00075	.00075	.00075	.00075	.00075	.00075	.00075	.00075	.00089	.00069
2 1/2			.00067	.00067	.00067	.00067	.00067	.00067	.00067	.00067	.00067	.00067	.00067	.00067	.00080	.00062
2 3/4			.00061	.00061	.00061	.00061	.00061	.00061	.00061	.00061	.00061	.00061	.00061	.00061	.00073	.00057
3			.00056	.00056	.00056	.00056	.00056	.00056	.00056	.00056	.00056	.00056	.00056	.00056	.00067	.00052
3 1/4			.00052	.00052	.00052	.00052	.00052	.00052	.00052	.00052	.00052	.00052	.00052	.00052	.00062	.000484
3 1/2			.00048	.00048	.00048	.00048	.00048	.00048	.00048	.00048	.00048	.00048	.00048	.00048	.00058	.000447
3 3/4								.000449	.000449	.000449	.000449	.000449	.000449	.000449	.00053	.000418
4								.000422	.000422	.000422	.000422	.000422	.000422	.000422	.00050	.000392
4 1/4									.000395	.000395	.000395	.000395	.000395	.000395	.000469	.000368
4 1/2									.000374	.000374	.000374	.000374	.000374	.000374	.000443	.000349
4 3/4									.000355	.000355	.000355	.000355	.000355	.000355	.000421	.000330
5									.000337	.000337	.000337	.000337	.000337	.000337	.000400	.000313

SIZES BELOW ZIG-ZAG LINE ARE SUBJECT TO BUCKLE AND SHOULD BE AVOIDED.

FIG. 9 TORSIONAL DEFLECTION OF SHAFTS IN RADIANS PER INCH OF LENGTH

minor-diameter shaft is employed for all classes of fit with the exception of the free fit where the minor diameter is made 0.0015 in. to 0.0019 in. smaller.

In the four classes of fit from sliding to press fit, the fit is made by varying the hole size. This is contrary to general practice in making fits between shafts and cylindrical holes, but in design work on splined shafts cases are frequently encountered in which it is necessary to have a part with a press fit and a part with a sliding fit on the same shaft, and it is economical to hob, mill, and grind a shaft to a uniform size. The free fit is used where a part is supported by its own bearings and slides on a long splined shaft which transmits torque only to the part. This fit is obtained by sinking the hob or milling cutter slightly deeper, giving somewhat more clearance between the sides of the keys and keyways as well as appreciably more clearance between the shaft and the hole.

Tolerances for the minor-diameter type of fit are shown in Fig. 3, while tolerances for the key type of fit are shown in Fig. 4. It will be noted that in the latter case the sides of the key cannot be ground economically after heat-treating, and it is necessary to increase the tolerance on the keyway. If the parts are broached and used without further heat-treatment or hardening, then the keyway tolerances can be reduced.

The tolerance chart for the major-diameter type of fit is shown in Fig. 5. If the parts are not heat-treated after broaching, the tolerances of the outside diameter of the hole can be decreased.

TORQUE CAPACITIES

A design discussion on spline shafts would not be complete without some mention of torque capacities. The four tables in Figs. 6, 7, 8, and 9, were compiled several years ago for the guidance of engineers and designers at the author's plant. These charts have proved very useful and successful. Since they have not been published heretofore, they are included in this discussion. Horsepower and torque capacities and the torsional deflection of 6-spline shafts, shafts with a single keyway, solid shafts, and tubular shafts, figured on a basis of 10,000 psi stress, are given in a form convenient for the designer to apply. Modifying factors for changes in shaft diameter are given in Fig. 6. These tables probably will be of value to engineers faced with similar problems of design.

It is the author's opinion that with the successful introduction of the involute-spline standard, the straight-sided spline should and probably will be used less and less. However, where parts must be hardened and cannot be machined, except by grinding after hardening, the minor-diameter-fit straight-side spline offers definite advantages.

ENGINEERING TRAINING

Relations of the University and Industry in Developing Engineers

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An adequate exploration of the areas of co-operation of industry and university in the field of engineering training is beyond the scope of a single paper and beyond the capacity of a single author. Expression should be given to the interests of the university as well as of industry, and it is more than possible that the trainee harbors the idea that he, too, has a concern that suggests participation. Priority, however, does not slant toward any single one of these but arcs over them and rests on the aggregate. Once this is recognized, there can be no serious objection to a vigorous exposition of the subject from the viewpoint of industry, although it is to be expected that such a dissertation will encounter strong differences of opinion.

NEED FOR GREATER CO-OPERATIVE EFFORT

There are some rather compelling reasons that should prompt industry to seek more fruitful relations with the technical school or university. The engineer, in design primarily and in manufacture secondarily, establishes economic bases which, if unsound, endanger the whole corporate health. With increasing labor costs, lower individual productivity, higher ratios of indirect to direct labor, higher break-even points and higher taxes, much greater reliance will have to be placed on engineering if any profits are to be made and if free industry is to survive. Yet there appears to be a veil or curtain that separates the operations of industry and the university in so far as their training efforts are concerned.

SURVEY INDICATES NEED FOR CONCERN

In preparation for this and two companion papers[1] the Education Committee sent questionnaires to representative Midwestern industrialists, asking for pertinent information regarding their policies and practices in developing technical personnel for greater responsibility. The data indicate that, except for a few commendable cases, the co-operation of industry with the university is but a feeble gesture. We walk our separate paths and nod politely when they cross.

The results further indicate that close to one half of the companies reporting have absolutely no plan for training the graduates after they get them. Another third make a conscious but very informal effort to train and acclimate. Those that enlist university help or guidance are extremely few. Table 1 summarizes the results of the survey.

The weakness is especially apparent in the smaller companies, some of which depend upon large companies for graduates of the more formalized training efforts, and some of which hire the graduates of universities directly and let them make their own adjustments and transitions. This seems particularly unfortunate because of the splendid opportunities which exist for individualized training and follow-up of small groups. Perhaps it is expecting too much for a single company to create co-operative methods and programs suitable to this purpose.

Industry may look with disinterestedness on the university or technical-school programs, but it cannot escape the fact that the output of these institutions constitutes the source of the most important ingredient going into their own products.

PRESENT RELATIONS BETWEEN UNIVERSITY AND INDUSTRY

The several fields and levels of engineering education and training, considered in their co-operative aspect follow:

Undergraduate. Little co-operation of industry with the university; an occasional lecture by a professional engineer; plant visitations; some students employed in industry during summer months.

Undergraduate Co-Operative. Alternate periods of schooling and working. A decided step forward but co-operation not thoroughly developed. Too much dependence upon what student can pick up; foreman not sufficiently trained to train. Co-op students should have a sponsor engineer and a shop educational program.

Undergraduate Evening College. Individual and voluntary relationship between student and school; co-operation between the school and company a minimum.

Sub-College Engineering Educational Courses. Both day and evening; source of large percentage of industry's technical and engineering staffs; entirely by student initiative.

Engineering Correspondence Courses. Men working in industry generally on technical operations who supplement their on-the-job training with academic work in absentia; not necessarily directed toward a degree.

Graduate Engineer Training. Industry-controlled and operated; varies from well-developed courses to entirely informal arrangements; industry-university co-operation usually undeveloped; more a custom of industry taking over.

Postgraduate Education. Traditional higher education. Some students work on industrial research projects; participation of industry usually small or nonexistent.

Master's Wisconsin University-Industry. Co-operative arrangement between the University of Wisconsin and Milwaukee industry; work rather independently. (See Appendix 1.)

Master's "In-Industry"—The Allis-Chalmers Plan. Operated in conjunction with Illinois Institute of Technology; instruction is given at the plant; co-operation is highly developed. (See Appendix 2.)

Keymen Training—The Falk Plan. Provides intensive education relative to company operations; plan developed with the dean of engineering of a large university; includes lectures on community and citizenship responsibilities, as well as design, operation and management; monthly full-day seminars.

A PAUSE FOR INTROSPECTION

One could hardly conclude from this that co-operation between industry and the university is fully developed. Probably the fault should be laid at the door of industry. Industry is the customer and should give some expression to its needs. Moreover, part of the training of the engineer must take place within industry, and it is here that the poorest job of all has been done.

The indicators of good health in engineering educational pro-

[1] "Industry Develops Engineers," by T. B. Jochem; and "Milwaukee Plan of Aptitude Testing," by E. C. Koerper.

Contributed by the ASME Education Committee and presented at the Semi-Annual Meeting, Milwaukee, Wis., May 30–June 5, 1947, of The American Society of Mechanical Engineers.

TABLE 1 SURVEY OF INDUSTRIAL PRACTICE IN DEVELOPING TECHNICAL PERSONNEL

	—Practice in developing personnel—			"In-company" activities			"Out-company" activities		
Size of company	Highly organized program	Informal program	No program	Conferences	Classes	No comment	Encourage society membership and participation	Sponsor continuation of formal education	Indifferent
M	X	—	—	—	—	X	X	X	—
L	X	—	—	X	X	—	X	—	—
L	X	—	—	—	—	—	X	—	—
S	—	—	X	—	—	X	X	—	—
M	—	—	X	X	—	—	X	X	—
S	—	X	—	X	—	—	X	X	—
L	—	X	—	—	—	X	—	—	X
S	—	X	—	—	—	X	X	—	—
L	X	—	—	X	X	—	X	X	—
L	—	X	—	X	—	—	X	X	—
L	—	—	X	—	X	—	X	X	—
L	—	—	X	X	—	—	X	—	—
L	—	X	—	X	X	—	X	X	—
S	—	—	X	—	—	X	X	—	—
S	—	—	X	X	—	—	—	—	X
L	—	—	X	—	—	X	X	—	—
S	—	—	X	—	—	X	—	—	X
S	—	X	—	X	—	—	X	X	—
L	—	—	X	X	—	—	—	X	—
L	—	X	—	—	—	X	—	—	X
M	—	—	X	—	—	X	X	X	—
L	—	X	—	X	—	—	X	—	—
L	—	—	X	—	—	X	—	—	X
L	—	X	—	—	—	X	X	X	—

NOTE: S, small; M, medium; L, large.

grams must be obtained from an evaluation of the preparedness of the trainee graduate. The vine is to be judged by its fruit. We must ask ourselves in utter frankness whether we are jointly doing the kind of a job that society, the taxpayer, the stockholder, the student and the customer have a right to expect. Does the school meet the requirements of industry and does industry adequately train and foster?

As a minimum the graduate should be expected to function as an engineer in some subordinate capacity, after a reasonable training period. This calls for more than a knowledge of technological procedures. The engineer interprets needs and then responds with ideas, sketches, blueprints, material, and functional structures designed to satisfy those requirements. Correlation of individuals, as well as of ideas and matter, are involved all along the line. He must know how to work in concert with others and how to communicate ideas to them. It is obvious that there is a sociological as well as a technological area of development.

OBJECTIVES MUST BE RESTATED

The entire field of engineering education-training should be re-explored and reoriented. A broad-gage national committee, consisting of representatives of industry and university, provided with adequate funds to finance full-time research and study would constitute an instrument for coming to grips realistically with the problem. Such a group could be expected to create plans for improved relations between school and industry as well as recommendations for accomplishing objectives which would include the following:

1 Training of engineers for greater power, imagination, resourcefulness, and courage; men who "accentuate the positive."

2 Provision of a more practical training. Making men who can do things; men who have actual skills rather than potential ones.

3 Instilling cultural tastes and habits together with an objective philosophy of life, a social consciousness, and a sense of industrial togetherness. Development of men with spiritual insights, and mature loyalties.

4 A reduction in the time (4 years of college and a minimum of 5 years in industry) required to produce an engineer capable of assuming responsible charge of engineering projects.

PREPARATION CAN BE TECHNICAL AND PRACTICAL

Much of the activity carried on in the engineering colleges should be relegated to the preparatory schools. The only reason for teaching rudimentary drafting at that point is to suit the needs of a small percentage who did not make up their minds before graduation that they might like to take engineering. All of the instruction in elementary machine shops, pattern shop, foundry, and weld shop could be obtained prior to university matriculation. The student would then have obtained his "tools" at an age when he can develop dexterity as readily or even better than later. Eventually, university engineering courses should be developed for students who are graduates of our technical and industrial high schools or have an equivalent preparation.

Some years ago a young man who had just completed his second year of academic high school consulted the author about transferring to technical high school even though it was certain that he would go on to the university. Being himself a graduate of such an institution he urged the student to try it. During the summer following his third year at Purdue the youth laid out a series of units which involved design techniques not ordinarily attained earlier than two years after graduation. This would indicate some startling possibilities.

Such preparation makes possible more advanced and more practical instruction at college. For instance, outside engineering service is engaged by many companies to handle the overflow of their drafting departments, usually detailing and simple layout. As often as not the organizations are in different cities. Technical colleges could participate in work of this kind, with the result that the youth would feel he was doing something "for keeps" instead of practice; there would be earlier orientation and a source of income for the school. The same holds true of certain shopwork. Much of industry's testing could be carried on in the school laboratories; tests on new products, determination of operating characteristics, and safety factors would bring the student into contact with the most modern

industrial units in place of the too frequently archaic ones. Again there would be income and that psychological value, the satisfaction which comes from practical service.

Earlier technical activity in the preparatory stages would be of considerable benefit to the student who leaves school before graduation, as well as the one who should never have registered at an engineering school but does not find out until it is too late. There is an instinctive and intuitive element essential to the profession that can be fostered and developed but not taught. Those not blessed with it must do the noncreative jobs.

We all know that many engineering graduates spend their lives in jobs which could be filled with contented men of high-school education or less. We know, too, that many of the university graduates gravitate toward jobs which in the strict sense of the word are not engineering but in which an acquaintance with its methods is useful.

When electives or majors leading to specialization are involved, aptitude testing should be employed to make sure that decisions are properly made. This also applies to graduate study. Whether any such study should be permitted without a year or more in industry should be considered carefully.

FUNDAMENTALS SHOULD BE EMPHASIZED

The observations of many engineering supervisors lead them to the conclusion that far too much of the college effort is devoted to application, specialization, and nonessentials and that there is insufficient grounding in fundamentals, principles, and methods. While it is true that almost any course of study develops the mind, it seems more practical to do it with useful materials of instruction. The small percentage of engineering graduates who will employ any given specialized course to an appreciable extent suggests confining the elements of such instruction to one of the basic courses. Because of the difficulty of keeping abreast of technological developments in industry, a student entering a specialized field has to relearn much of what he has covered in that field. Mechanics, mechanism, statics, and dynamics on the other hand are drawn on in almost any engineering field of endeavor and their truths are eternal. Possibly a year could be saved and yet the knowledge of fundamentals intensified.

CREATIVE FACULTIES SHOULD BE NURTURED

We think of the scientific method as the collection of all pertinent facts, both wanted and unwanted, their arrangement into systematic categories from which may be drawn intelligent conclusions. The observer in science coldly records without interjecting his personality into the situation. He lets nature do all the talking. The process in itself is not creative. Differing from the inductive scientific method, a new concept, a new synthesis or an invention involves a leap of the imagination beyond the point where science stops. Too great a respect for the prevailing notions as to what cannot be done may inhibit the creative instinct. This arises first of all from a dulling of the imagination, a taming of the spirit, which in an untutored Edison runs strong and wild and free. Furthermore, it develops from the fact that the false logic which indicates the impossibility of accomplishment frequently neglects an important factor or contains one of a variable nature.

There can be little doubt that much of the instruction can be reorganized to develop original thinking. Admittedly it takes more time. We can teach Euclidean geometry by supplying the student with the axioms only, assigning theorem one, and having him find the solution without reference to a text; then with his axioms and theorem one, solving theorem two, and so on. Or we can teach it the conventional way in which he need only follow prescribed patterns. A similar approach is possible in mechanics, physics, and other subjects.

Thought should be given to the use of certain classics for test, such as Newton's "Principles of Philosophy," or Faraday's "The Forces of Matter," which permit retracing original thinking and repeating the original experiments. The undergraduate as well as the industrial-training effort should abound in projects calculated to bring out the latent creative talents and develop the artistic nature of the embryo engineer.

UNIVERSITY CAN PARTICIPATE IN INDUSTRY TRAINING

An enlightened self-interest would suggest realistic company attitudes toward engineering training responsibilities. The chief engineer should feel just as much concerned about developing engineers for future operations as about developing products for future sales; and the boss has a perfect right to evaluate him on that basis. Much of the mechanics of training is turned over to the personnel department but that does not relieve the engineering department of its share of the responsibility.

The Falk Corporation for many years has exhibited a genuine interest in employee development, and its pioneering work in the field of apprenticeship is well known. One of the heads of its personnel and training departments went directly to a large university as dean of engineering but has recently been guiding a program of advanced training at the corporation. Certain of the techniques employed show particular promise even though it is too early to report in detail. Suffice it to say that the university can be of great assistance in training beyond graduation, versed as it is in the art of communicating ideas and arranging programs. Industry will find the help of professional instructors essential to the development of a well-rounded training course.

SCHOOL AND INDUSTRY MUST GET ACQUAINTED

European technical education has long contended that instruction should come largely from men who have attained recognition because of their industrial experience and achievement. The claim is made that more practical graduates are obtained. Many of the "technikums" require one or more years of experience in shops before matriculating students. There is not too much reason to borrow from abroad, but certain subjects suggest a high degree of co-ordination with practice. Should these areas be developed, many industrial problems could be referred to the university.

Manufacturing concerns employ management and production counsel during times when revisions of departmental operations are under consideration. These consultants could very well operate from the technical schools and might even be part-time faculty. Thus a common reservoir of modern methods and procedures would be tied into the school. Students specializing in this field could be used in the detail work of collecting data and installing new systems.

Greater recognition of the fact that many engineering graduates move into supervisory manufacturing positions must be reflected in the curricula. Tooling and processing are of rather general interest and helpful to the embryo designer as well as to the production expert of tomorrow.

Certain manufacturing associations having heavy technical programs invite professors to participate in their activities under academic membership. This brings to the school a better understanding of the problems of industry together with a more practical approach than is otherwise possible. This has demonstrated its usefulness and therefore should be extended.

LEADERSHIP CAN BE CULTIVATED

An industrialist who built up a good-sized industry helped his children plan their university curricula so that they would have "that to live by, that to live with, and that to live for." The engineer should have a particularly broad base for his

education since his vocation is of a confining character. There is room for considerable difference of opinion as to the degree of cultural emphasis practical in the education and postgraduate training of the engineer. A background that recognizes the streams of culture that constitute the basin of twentieth-century civilization can serve as a stimulating beginning of the full life. The school can inculcate principles, ground a philosophy of life, develop attitudes, create thirsts and instill a sense of values which will provide a cultural beachhead for future excursions into the aesthetic.

One of the justifiable complaints about university graduates is that of immaturity. It is barely possible that the relationship between professor and student tends toward deflation of the youth at an age when he should be asserting the positive attributes of personality. Students should be encouraged early to participate in civic enterprises and enlist in the work of social agencies. This should be paralleled with lectures by individuals likely to stimulate proper interests. A good citizen, a "whole man," and a resourceful engineer need not be strangers to each other.

When industry receives the graduate it must be with warmth and understanding. He is making a readjustment of no mean proportions, and he is doing this just as he reaches maturity, a time when the urge to hold his head high and throw back his shoulders is greatest. The trainee should not be denied any legitimate opportunity for development. The author is finding that these men can be used directly on preliminary design where the ideas are not yet sufficiently organized to release them from his own personal supervision. Some of these fellows exhibit a delightful enthusiasm and freshness and are unencumbered by too intimate a knowledge of existing constructions. Once they have absorbed sufficient background they must be permitted to go on to operations which call for independent action and early responsibilities. If we put the right kind of challenge up to them they will come through with a proper response. These are the seed brains for tomorrow.

The engineering trainee must learn to work unselfishly and co-operatively toward the attainment of the over-all objectives of industry, have faith in his company and its leadership, and exhibit a quiet and dignified devotion to the free competitive way of life. Faced with the reality of competing pagan totalitarian forms of organization, the imperative demands that the first concern be the interests of a free society. Leadership is attained only when one gives himself to something outside himself. Paradoxically, this secures the primacy of the individual, and the dignity of the person.

When the contemporary poet Robert Frost penned the line, "Men work together whether they work together or apart," he stated a truth applicable to all human participation; but it is certain that it has an especial significance for industrial society, particularly so in the field of university-industry relations in the development of engineers.

Appendix 1

GRADUATE PROGRAM AT MILWAUKEE EXTENSION CENTER OF THE UNIVERSITY OF WISCONSIN

This program offers a postgraduate university-industry co-operative arrangement between the University of Wisconsin and employers whereby men working in industry obtain credits toward a master's degree. Complete instruction is available leading to the master's degree in every branch of engineering and in engineering mechanics at the Milwaukee Extension Center of the University of Wisconsin. Normally, the work will require three years of night school, with no residence on the campus in Madison. Candidate must have earned his bachelor's degree in engineering with a high C average at an accredited college or university. After obtaining a letter from his employer approving the thesis work involved, he arranges his program with a University of Wisconsin major professor. Registration and conferring of degrees is handled at Madison.

Appendix 2

ALLIS-CHALMERS GRADUATE PROGRAM

The Master's Degree at West Allis. A co-operative relationship has been set up between the Allis-Chalmers Manufacturing Company and Illinois Institute of Technology in which the same graduate courses with the same course content and, in so far as possible, the same instructors are provided in the West Allis plant as on the campus in Chicago.

Registration is limited to Allis-Chalmers employees. An average grade of B or higher in undergraduate work, or the equivalent in terms of the grading system used, is a necessary prerequisite to admission to candidacy for an advanced degree. The work for the degree is normally completed in three to four years.

Courses of study are available in the fields of electrical engineering with the power option, and the electronics option; and mechanical engineering with the machine-design option and the heat-engineering option. Supporting courses and advanced mathematics, industrial engineering, mechanics, and physics round out the minor field of study for the degree, and provide a series of suitable electives.

The Graduate Fellowship. Allis-Chalmers has established a graduate fellowship at Illinois Institute of Technology, providing for three semesters of study on the campus in Chicago, which normally leads to the master's degree.

The engineer selected for the fellowship must be recommended by his engineering department; must have a professional interest in engineering; preferably shall have been employed by Allis-Chalmers for one year prior to selection; must be a graduate of an accredited engineering college; must demonstrate an understanding of the type of problems he will work on, and agree to an approved research assignment. He should anticipate returning to regular work at Allis-Chalmers upon completion of studies.

The grant of the fellowship will be sufficient to pay for the tuition, fees, and research expenses at the school plus a salary for the fellow. The subject for research on the fellowship will be jointly agreed upon by Illinois Institute of Technology and Allis-Chalmers Manufacturing Company.

INAUGURATION of a program which will permit university and college faculty members in chemical engineering to gain a full year's on-the-job experience in the chemical industry was announced recently by the Monsanto Chemical Company.

Teachers chosen for participation in the program will be paid the salary ordinarily paid for comparable jobs within the company, and their moving expenses to and from the plant to which they are assigned will also be paid by Monsanto.

Motivation for the plan is the need to give younger teachers much-needed practical experience in industrial operations. This experience, it is hoped, will be utilized in teaching successive classes of students over a period of years. While some teachers occasionally serve as consultants, they do not in these capacities gain the firsthand working knowledge of plant operations which permits them to render fully effective guidance to students under them who are about to enter industry.

Under a previously announced program the company's industrial scientists have been permitted to return to universities of their choice for an academic year of study at full pay.

INDUSTRY *Develops* ENGINEERS

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THE development of the engineer is a joint responsibility of the colleges and industry. During his college years, the engineering student should concern himself primarily with acquiring knowledge of the fundamentals of the science of engineering, a field which is sufficiently extensive to demand the greater portion of his time. The college graduate who is well grounded in engineering fundamentals possesses a sound foundation upon which he can build a store of knowledge most useful to the industry by which he is later employed.

A college graduate is not a full-fledged engineer, and it is just as erroneous to consider him such as to consider the graduate of a medical school a full-fledged doctor before his internship. Just as a doctor spends several years as an intern, so must the engineering graduate spend some time in a more or less intensive training period designed to bring his basic knowledge into harmonious relationship with the practical applications peculiar to the particular industry in which he is employed. It is precisely here that the young engineer needs the assistance and guidance obtained in a well-defined training course in industry.

INDUSTRY'S VIEWPOINT

From industry's viewpoint, the training of young engineers is equally important. Industry owes something to the profession. To maintain a position in a competitive field, a company must draw heavily on the store of engineering knowledge accumulated through the activity of a countless number of technically trained minds, a store of knowledge to which the company may have contributed little. No one denies a company the right to draw on this knowledge and to use it for its own legitimate ends. However, every right imposes a corresponding duty, and every industry has the obligation of adding to that store of knowledge from which it has drawn and from which others will draw in the future. This storehouse is the record of achievement of the members of the engineering profession, and it grows and expands through individual and unique mental activity of the engineer. Much of this mental activity is self-stimulated. However, management can play an important role in prodding the engineer's interest, in making available the means of self-improvement, and in training the engineer actively, at least along the lines of the particular field in which the company operates.

Most industries have become highly specialized. The designs and techniques developed by a particular industry over the period of its operation cannot be taught in college. Even though this were possible at any particular time, the knowledge would shortly be obsolete because of the present rapid advancement in all engineering fields. The difficulties encountered in matching a specialized knowledge to a particular job are obvious. Industry is forced to take over the field of specialized training if it wishes to make the most effective use of the engineering talent in its employ. Actually, industry should be happy that the young engineer is at a stage in his development where he can be trained most effectively along the specialized lines peculiar to the industry.

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POTENTIAL VALUE OF THE YOUNG ENGINEER

Another important consideration deals with the young engineer himself, and his potential value to the company. When a young engineer seeks employment in a particular company, he is in effect offering his abilities, physical and mental, to that company to be used along the lines directed by management. By virtue of this offer he is expressing a willingness to devote to the company interests an individual mental capacity, something which he alone is free to give, potentially unlimited in its capacity for promoting advancement of the company in its field. As such, the young engineer is a valuable asset on the company's books. Like any other asset, his value to the company can be increased by proper handling or can be made worthless by a disregard of the potentialities in the individual. True, much of the increase in value depends upon the young engineer himself, upon proper utilization by him of the faculties which he controls. But the very fact that this valuable asset is placed in company hands justifies no small effort in developing the capabilities along lines most advantageous to the company.

We might summarize the reasons for the training and development of engineering personnel by industry as follows:

1 Industry has a responsibility to the engineer and to the profession to promote and add to the store of engineering knowledge. By thorough and continued activity in the development of its engineering personnel, industry is discharging this duty since it is sharpening the tools capable of outstanding engineering achievements.

2 Specialization requires specialized training which colleges cannot hope to provide. Industry is best suited to provide this training; in fact, it is an economic necessity that industry do so.

3 Industry should regard young engineers, and for that matter all engineering personnel, as valuable assets capable, by proper handling, of achievements of a value far exceeding the effort expended in training and developing the personnel.

THE SURVEY

In order to obtain firsthand information on how industry in the Milwaukee area is meeting the problem of developing engineers, a questionnaire was submitted to 75 representative companies. This questionnaire requested comments on the following points.

1 The company policy and practice in developing technical personnel for greater responsibility or for more effective discharge of present responsibilities.

2 Procedure and criteria for the selection of technical personnel.

3 "In-company" activities for broadening or specializing technical personnel along lines such as technical, personal, administrative, economic, etc.,

4 "Out-company" activities; such as, co-operation with educational institutions, technical and professional societies, etc.

Replies were received from about 50 per cent of the companies contacted. The material relating to the development of engineers directly by industry is included in this paper. The information was analyzed and catalogued under general headings: namely, "Co-operative Training Courses," "Graduate

Student Training," and "Advanced Training of Engineering Personnel."

Co-Operative Training Courses. Co-operative training in industry at the undergraduate level was not specifically mentioned in the questionnaire. It is a form of industry-college co-operation which is being carried on effectively in this area. At the present time, Marquette University has approximately 150 senior and junior students, or about one third of those eligible, under this plan. The choice of co-operative training or of a continuous college course is optional with the student, but once the choice of co-operative training has been made, the student is expected to complete his course under this plan. After completion of the sophomore year, those students who choose the co-operative course are divided into two sections, one student in each section being assigned to a particular job. The choice of company under the plan for each student is based upon the student's preference as to the type of industry and industrial activity. Any assignment of company and job training must be mutually agreeable to the student, the university, and the company. The student then embarks on a program of 3 months in industry, followed by 3 months in school, and continues on this schedule during his junior and senior years, approximately $2^1/_2$ years.

Before the student is assigned to any company, the latter must submit a well-planned program of on-the-job training involving work in various departments, a plan which must be approved by the university. At present, 40 firms in the Milwaukee area are co-operating with Marquette University in this type of plan. Approximately 50 per cent of these fall in the classification of smaller companies. The university recommends that the company provide some supplementary lectures whenever this is possible. Graduate students who are employed by the company in which they received their co-operative training are usually credited with 6 months on the graduate training program if the company has such a program.

Graduate Student Training. Material for this portion was analyzed on the basis of the formality of the student engineer training program. The information fell more or less naturally into one of four divisions, although there were a few cases where the program overlapped two divisions. The divisions are as follows:

1 The first section comprises those companies which provide a well-defined student engineer training program, including scheduled on-the-job training, supplemented by lectures. The companies schedule a work program for trainees involving assignment to various shop and office departments for a more or less definite period of time. Supplementing this work program, and usually carried on during the same period, lectures are given covering engineering theory as applied to the company's products, departmental functions, and general company operations. The lectures may or may not include written material. They are usually delivered by supervisory personnel and involve examination periods to test the student's knowledge. Of the companies reporting, 27 per cent provided this type of formal training.

2 This section includes those companies which provide a more or less formal on-the-job training program but which omit the formal lecture course. Of the companies reporting, 20 per cent use this type of training program.

3 Some companies provide supervisory training only in the department to which the young engineer is assigned. This consists of personal training by the department head or the immediate supervisor of the engineer. There is no, or a very limited, shifting of the engineer to other departments. The degree of effectiveness of the training depends to a great extent upon the supervisor's interest in providing it. About 12 per cent of the companies reported this type of training.

4 This section includes the companies which provide no particular training for the young engineer except as might be encountered by him in discharging the duties connected with his assigned job. Of the companies reporting, 30 per cent fitted into this category.

5 No comments on any of the items in the questionnaire were indicated by 8 per cent.

Summary of Data. 27 per cent of the companies provided a formal program of on-the-job training plus lectures; 20 per cent have a program of on-the-job training only; 12 per cent provide only limited training under the supervision of the engineer's immediate superior; 30 per cent essentially provide no training for young engineers. It is interesting to note that the 47 per cent in the first two divisions, those providing a more or less formal training program, checks closely with the 50 per cent for this classification encountered in a national survey conducted in 1947 by the Engineers Joint Council.

THE IDEAL TRAINING SCHEDULE

The formal program involving on-the-job training supplemented by lectures represents the ideal training schedule for the young engineer entering industry. In this area, this type of program is found in most of the larger companies and is limited almost exclusively to the larger companies. It is regarded as an economic necessity by these companies. In these companies, the diversity of products and the large number of departments involved in the manufacture of these products result in a complex manufacturing procedure, an over-all view of which can be gained only by a well-planned training program.

These programs involve more than a study of manufacturing procedures. The courses include, as well, a review of fundamental theory applicable to the particular product, a thorough study of product design and application, a detailed study of departmental functions and interdepartmental operations, and some data on company-customer relations.

In short, the courses are designed to orient the young engineer in the job and to provide that all-important link between basic theory learned in college and practical application of that theory in industry. That this type of formal program is justified in the larger companies is obvious. However, it is not so apparent that a program of this nature can be economically handled by a smaller company.

If we recognize the necessity for training young engineers, as indicated earlier in this paper, we are compelled to think along the lines of providing some such training for engineers entering any company, large or small. The author believes that a formal training program involving in essence all the details included in the foregoing can be handled as economically by a small company as by a large concern.

PRACTICAL PROGRAM REQUIREMENTS

Of primary importance in any training program is an organizational setup which will supervise the program and assume responsibility for its successful operation. In a small company, this will undoubtedly involve only the part-time activity of one man. But it is important definitely to assign responsibility for setting up and maintaining the program, and it is equally important to emphasize the primary position of the program in the company organization. The program itself might be divided into five broad phases, as follows:

Orientation. This consists in acquainting the young engineer with the company, the personnel, the organizational plan, departmental functions, etc. In a small company this phase involves little expenditure of time and effort. The actual procedure may take the form of a short lecture or a personal discussion supplemented by an organizational chart.

On-the-Job Training. A work program which involves some

actual time in the various departments is essential for an effective training program. The length of time spent in each department of a small company would be relatively short, possibly only 2 or 3 weeks. Actually, a large company has a much more complex problem in this phase of the program.

Lectures. A lecture course which may take the form of a series of personal talks on company products and the correlation of theory and application in regard to these products is as important in the program as the work phase. Where supervisory time is limited, some of the material can be studied by the trainee himself through references to articles, books, and publications on theory and application along the lines of the company's products.

Tests. The program should include periods for testing the student's grasp of the material presented in the preceding phases of the program. This is extremely important since it emphasizes to the student the seriousness of the program and compels him to engage in personal mental activity along guided lines.

Final Training. This consists in training the engineer in the particular job to which he is permanently assigned. This must be done under any circumstances.

Any of the foregoing phases can be modified to fit a particular company. However, it should be emphasized that none of the phases can be omitted without seriously limiting the effectiveness of the program. In the long run a formal training program of this nature will pay handsome dividends to any company, large or small.

ADVANCED TRAINING OF ENGINEERING PERSONNEL

The questionnaire was worded so as to obtain some information on the company's policy as regards continued development of engineering personnel. The responses are divided into in-company activities and activities outside the company but which are encouraged and in some cases sponsored by the company.

The in-company activities were analyzed and are listed under four general divisions:

1 Conferences and meetings in the home office for the purpose of discussing products and new designs. Practically all of the companies replying listed this as a means of increasing engineering knowledge.

2 Distribution of literature, magazines, patents, and letter releases on new products, manufacturing methods and material. About 75 per cent of the companies indicated that this method of providing information was used. Most of the companies subscribe to trade magazines and distribute literature among the engineering personnel with the expectation that they become familiar with the material relating to progress in their particular fields.

3 Attendance at conventions and meetings; 50 per cent of the companies regarded this as an important method of developing engineers and made this form of training regularly available to their engineers.

4 Specialized training on company time and under company supervision; 15 per cent of the companies indicated that they had used or were at present carrying on this type of training. The training here referred to includes but also goes somewhat beyond technical subjects.

SPECIALIZED TRAINING COURSE

It may be of value to illustrate this specialized training by reference to such a course now in operation at the Falk Corporation. The purpose of this course is to impart information concerning the corporation, its organization, products, and departments, and to afford training in co-operating with these departments. In addition it reviews or explores in a preliminary manner engineering fundamentals and attempts to impart understanding of business and industry in general, and social and economic movements.

It is specialized in that it draws for its members employees, technical and nontechnical, who have shown leadership characteristics and attempts to expand and enlarge these abilities so as to be able to utilize the personnel most effectively.

In operation, the course consists of conference days once a month, at which various topics covering the foregoing general outline are presented. The conference leaders are picked from the company where the subject deals directly with the company and its products, and from outside sources for the general subjects. In addition to technical subjects and discussions of the company organization, such topics as Definition and Methods of Engineering, Movements and Trends in Engineering, The Industrial Revolution and Machinery, Modern Manufacturing, Corporate Organization of Business and Industry, Business and Government, Social and Community Relations of Business and Industry, and Personal Efficiency are covered.

Review sessions are held in the month following each lecture in which the trainees are expected to present their views and discuss problems presented at the previous session. An individual oral examination before the governing committee is held at the close of the course. The trainees are rated on their general knowledge of the material, their ability to think originally and to express themselves clearly.

OUT-COMPANY ACTIVITIES

Out-company activities listed in responses to the questionnaire are as follows:

1 Encouragement of the personnel to join local and national engineering organizations. Of the responding companies, 75 per cent indicated this as a definite activity; about 10 per cent stated that all or part of the dues for membership in these organizations is paid by the company.

2 Preparation of papers for publication or presentation at meetings and conventions. Approximately 35 per cent of the companies noted this as an activity encouraged by the company.

3 Co-operation with educational institutions by sponsoring or actively encouraging employees to take courses in specialized and advanced subjects. Of the companies reporting, 50 per cent gave this as a definite activity; 25 per cent of the companies pay all or part of the fees for these courses.

4 Encouragement of the engineering personnel to attend meetings and technical sessions of engineering organizations and to take active part in the activities of these groups. Of the companies reporting, 50 per cent gave this as a method of advancement of engineering personnel.

TRAINING ABOVE THE STUDENT LEVEL

It is hardly necessary to call attention to the important role played by engineering organizations in the development of engineers. That this is appreciated is evidenced by the high caliber of the engineering groups in the Milwaukee area. The Milwaukee section of the Society is an outstanding example of this. The high quality and the large number of technical meetings sponsored by various engineering groups in Milwaukee during the past year, and for many years, is an indication that industry recognizes the value of this method of increasing and disseminating engineering knowledge.

The lifeblood of the technical groups is the technical meeting, and the number and quality of the technical meetings depend upon the availability and the quality of the technical papers. The preparation of technical papers for publication or for presentation at meetings and conventions is a particularly potent form of engineering development, from the standpoint

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MILWAUKEE PLAN *of* APTITUDE TESTING

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WHAT are the basic differences between the abilities of individual engineers? Wherein is the difference between a researcher, a development engineer, a production engineer, and an engineering supervisor? We all know how little titles can mean and, all things considered, perhaps titles in placement procedure have been given too much weight. On the other hand I think we all agree that too little attention has been given to the basic contents of engineering jobs, job differences, and the broad selection and development of individuals for them.

There is great need for comprehensive techniques in the effective selection of engineers. This more precisely should include the selection, placement, and the development of engineers and engineering administrators. The two categories of "engineers and engineering administrators" are both treated together because of their merging and in many cases their overlapping interests.

Is the engineer a different animal or can his interests, abilities, and aptitudes also be measured with a reasonable degree of accuracy? Are engineering jobs of such a nature that they too can be specified? If so, reasonable efforts should be made to match individuals to jobs, taking into account the individual's ability or inability to grow. Jobs are not mere holes; engineers are not pegs, either round or square. It would be more apt to say, "You cannot keep angleworms in square holes of specified dimensions." The worm fits the hole to his dimension and if it doesn't suit he migrates.

Much effort has been devoted to the problems of guiding, selecting, and training engineers. However, something seems to be lacking. Too few of the selective techniques seem to be based on a broad enough base. Generally it was felt that most personnel selective methods involved one or more of the following general shortcomings:

1 The use and area of proved psychological test batteries were limited: Batteries of shorter length tended to be merely "go and no-go gages" for specific jobs in a particular company. When the scope of the tests were broadened, engineers often tended to become statistical summaries of psychometric jargon.

2 The use of patterned interviews with their demonstrated advantages were limited and in most cases were not integrated with other selective information.

3 The engineering jobs were poorly specified. This gave an inadequate basis for matching personal characteristics to job requirements.

4 The growth factor of the engineer was disregarded. Individuals in jobs too generally are considered static. The man can make the job, and this depends in part on the height to which he can or must develop in it.

5 The broad terminology of the test batteries, patterned interviews, job specifications, and progress evaluation lacked uniformity which often caused confusion or misunderstanding.

PLAN OBJECTIVES

It was the concept of the Professional Development Committee of the Engineers' Society of Milwaukee that much constructive work could be done in a co-operative effort, especially in a community with a wide variety of engineering work in a great diversity of large and small industries. The committee's approach and viewpoint were primarily professional, in which the objectives were the better selection and evaluation of engineering personnel toward their more effective utilization and recognition. The academic and industrial viewpoints were closely integrated into it.

It was felt that if the thinking were in more basic terms, perhaps more attention and effort could be focused toward the important factors or traits and their relation to each other on the job. We all deal in vague aspects of these fundamentals each day. However, much of this thinking lacks vigor and direction because the underlying pattern is not clear.

Out of the initial discussions of two years ago came the "Milwaukee Plan of Personnel Development in Engineering," which was then defined to cover and develop the following two related objectives:

1 Develop effective means for assaying and specifying the aptitudes, interests, and personal qualities of individuals in the variously related fields of engineering work; these to include research, design, production, sales engineering, engineering, management, etc.

2 Develop a comprehensive job-specification system for all engineering jobs. This to be used in conjunction with selection, guidance, and training procedures.

It was agreed that the plan should be workable on a very practical level and broadly applicable to virtually all types of engineers and engineering administrators; that all basic ideas should be mutually agreeable to the psychologist, the engineering colleges, industry, and the professional engineer; and that broad terminology on all phases of the plan be standardized and readily understandable to everyone involved.

PARTICIPATION AND AREAS OF INTEREST

In carrying out this rather ambitious program, believed to be the first of its kind, every effort has been directed toward results which will be scientifically sound and yet practical and broadly applicable. Toward that end the viewpoints, abilites, and judgment in the following areas of interest were closely integrated:

The University. Here the future engineer gets his technical foundation. Here also, as with industrial psychologists, new psychometric techniques are being developed and refined constantly. An opportunity is also provided to evaluate teaching techniques and curricula based upon developments coming out of the plan.

Industry. Here the engineer and the engineering administrator take and develop their places in complex situations. Properly placed each is of great value to himself and to his company. Improperly placed he becomes frustrated and is a liability.

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The Engineer. This is the man, and the potentialities in his profession, which we are discussing.

PROGRAM ACTIVITY

The plan activities center around the following five general fields and their correlation:

1 Psychological test batteries and their refinements: Selection and development of a minimum battery of interest, aptitude, personality, and achievement tests of known validity.

2 Patterned interview forms and techniques as an aid in supplementing and correlating other personal information.

3 Comprehensive workable job-specification system to cover virtually all engineering jobs: This system framework to be used for a basic description of all engineering job requirements in order to determine relations between types and characteristic fields of technical work. The descriptive terms herein should, when possible, be common to the test batteries and shall be in a form readily usable by department supervisors.

4 Employee progress appraisal methods to evaluate the performance of the individual in the specific job assignment.

5 Co-ordinating program designed to correlate the information secured in the foregoing stages in order to refine and expand its usefulness.

BASIC FACTORS OR TRAITS

It is not the purpose of the Plan Committee to provide all the detail for an inflexible recommendation. Rather it is attempting to establish a philosophy with sufficient tools and foundation for others also to co-operate and to carry on if the work meets a basic need. If the thinking is sound, the Plan could have broad adoption. From the support we have received, it is felt that we are forging in the right direction.

To some it might appear that too much emphasis is placed on original selection. Such is not the intent. It was the committee's belief that the most fertile fields were in the evaluation of personnel at present employed, and their job specifications.

It was felt that if terms were kept sufficiently broad, the basic characteristics of individuals and job requirements could be described by the following three categories and their characteristic factors or traits:

Preponderantly Technical

1 Comprehension of engineering principles
2 Level of technical knowledge
3 Mathematical aptitude
4 Organization of technical work
  (*a*) For own execution
  (*b*) For execution by others
5 Knowledge and preparation of engineering plans
6 Ability to deal with critical technical details
7 Scientific and research ability
8 Clarity of expression in
  (*a*) Speech
  (*b*) Writing

Preponderantly Psychological

9 Self-reliance and drive
10 Social intelligence and tact
11 Sales ability and interest
12 Leadership in work direction
13 Dependability in engineering work
14 Professional aspiration and development

Physical

15 General physical characteristics, conduct, and appearance

A number of people will be willing to argue these points, and their viewpoint is fully appreciated. As a matter of fact the most animated discussion came in this area. However, this terminology need not limit the value of the Plan as long as the factors are used consistently within their defined meanings. The committee welcomes suggestions and comments.

PROGRESS

Out of the efforts to date have come the following recommendations ready for use, which can be obtained from the Professional Development Committee by addressing the author:

Aptitude Test Batteries—A Summary	ATB-1
Preliminary Criteria for Trait Evaluation	PC-1
Patterned Interview—Outline Form	PIF-1
Job Specification System—Preliminary Outline	JS-1

Progress reports on the Plan and its application will be issued from time to time in conjunction with the University of Wisconsin and other co-operators. These will be available to interested and co-operating individuals and organizations. A psychometric manual is now being prepared.

CONTINUING THE PLAN

Through co-operating organizations, considerable assistance is available for initiating any phase of the plan. The three types of location in which the test batteries and patterned interviews can be given advantageously include the following

Engineering Schools. A student's personal qualifications are just as important as his academic accomplishments. By evaluating the man at this point the results can be made available to himself, also to others interested in his employment.

Co-Operating Industrial Companies. In numerous cases, some of the tests have already been given for a number of years. The general terminology of traits and factors recommended herein, the progress appraisal, and the job-specification system can be used generally with any test battery covering the area under consideration.

Engineering Societies. This type of organization offers unusual opportunity for professional development and guidance for its members who may not have other evaluative services available.

Each of these organizations has its particular problems and advantages. The integration of these efforts should help to develop the untapped potentialities of the engineer. His place is critical in our modern industrial civilization which becomes more complex hourly. If we as engineers utilize and direct our abilities, we can take a leading place in developing the greater destiny of mankind. We must not do less.

ACKNOWLEDGMENTS

It is the high degree of sustained interest and hard work on the part of the following most active collaborators from the universities, industrial companies, and professional engineers which have made possible the progress on the Milwaukee Plan. Grateful acknowledgment is also made to the many others who have contributed comments and suggestions.

Test Batteries. Dr. K. U. Smith, department of psychology, University of Wisconsin (chairman); Dr. G. S. Speer, director, Institute for Psychological Testing, Illinois Institute of Technology; Dr. Karl Wedell, director, Bureau of Industrial Psychology, University of Wisconsin; A. C. Siebers, director, Marquette University Guidance Center; C. Lewis, employment department, Allis-Chalmers Manufacturing Company; E. A. Cockrell, Wisconsin Electric Power Company.

Job Specification System. R. Falk, vice-president, The Falk Corporation (chairman); R. E. Govan, The Falk Corporation; W. L. Moss, Milwaukee City Service Commission.

Patterned Interview. E. C. Ulbricht, employment manager, Cutler-Hammer, Inc. (chairman); R. Schindler, Globe Union, Inc.; R. Kuchler, Transport Company; A. E. Rosier, American Appraisal Company; Mrs. Frances Voss, Perfex Corporation.

Ten Months of the TAFT-HARTLEY ACT

By E. H. van DELDEN

DIRECTOR OF INDUSTRIAL RELATIONS, LIBBEY-OWENS-FORD GLASS COMPANY, TOLEDO, OHIO

It has become evident during the past ten months that the Taft-Hartley Act is here to stay. It has already proved its value. It is no longer the Act which is on trial but the ability of management and unions to solve their problems within the framework provided. Any changes to be made are likely to be in the direction of strengthening rather than weakening the basic requirements of the law.

This statement can be justified in several ways:

1 The Joint Congressional Committee on Labor-Management Relations (the so-called watchdog committee) reported[1] on March 15, 1948, as follows: "...in over-all application, and basically controlling aspects, this law is working well, without undue hardship upon employer or employee, and promoting the adjustment of labor problems equitably and in more friendly and co-operative relationships."

2 Laws arise out of situations which require correction. Many times before the passage of the Taft-Hartley law, bills were proposed to control union abuses arising out of the inequities within the Wagner Act. Moreover, before the federal statute was enacted, the trend in state legislation had already become pronounced.

3 Legislation protecting the public from the effects of individual or group power complexes whatever their source is not likely to be repealed. The 1946 strikes, which paralyzed the nation's economy, resulted in public pressure for a two-edged national labor policy that would prescribe standards of union conduct just as the Wagner Act prescribed standards of conduct for employers. There seems no question but that, if the Taft-Hartley Act should prove inadequate to cope with situations endangering the national health and safety, Congress will strengthen those provisions of the Act.

All of us recognize that it is not possible to legislate industrial harmony. In a national emergency, however, an armed truce or an uneasy peace is certainly preferable to open rebellion. The strike has become a political as well as an economic weapon. The Taft-Hartley Act represents a Congressional compromise between public pressure to prevent strikes and the insistence of union leaders that they be free to do as they please. In the author's opinion it constitutes a final attempt to use reason instead of force.

EFFECT ON THE UNIONS

The results of ten months of operation under the Taft-Hartley Act indicate that collective bargaining has been maintained and strengthened as the law of the land. Union membership has not suffered and many unions have made substantial gains especially as a result of union-shop contracts entered into by majority choice of employees. One union periodical states,[2] "Labor's foes who hoped that weakening of the unions would result from the restrictive limitations and procedural red tape placed in the way of the union shop must be sorely disappointed."

Wages, either in average hourly earnings or in over-all "take-home" pay, have continued to climb. The right to strike has been circumscribed only to a minimum extent, yet strikes have not been unduly prevalent. Those which have occurred seem to have been the result of economic motives rather than of difficulties encountered under the Act. Most unions have qualified under the anticommunist requirement and those which have not are worried. Even the steelworkers are expected to comply after their convention. The purpose of bringing the Communists in the labor movement out into the open has been achieved without the chaos that was predicted. Perhaps, like Schopenhauer's famous remark about life, the Taft-Hartley law needs neither to be wept over nor laughed at, but to be understood.

The new era in labor relations ushered in ten months ago is based upon the principle of equal responsibility and the restoration of balance to the union-management relationship. Philosophers have long contended that there are only three ways of settling labor disputes: (1) by domination, (2) by compromise, and (3) by integration. Of the two types of labor disputes, the Taft-Hartley Act has laid the foundation for the settlement of disputes between unions; and the restoration of balance to union-employer relationships should result in settlements less in the direction of domination and more in the field of compromise and integration. The General Motors settlement might be considered a move in this direction. The union continues its liability under the Taft-Hartley Act and the company attempts to solve the wage problems of its employees as presented by their representatives.

Hearings were held recently in Washington concerning problems which have arisen under the Act, and the Joint Committee on Labor-Management Relations in a release dated May 4, 1948, especially invited testimony on five major issues.

AUTHORIZATION ELECTIONS

The first question concerns the provision requiring an authorization election before a union-shop contract. The release states the situation as follows: "The NLRB is flooded with petitions for such elections and the great majority held so far have been won by large majorities, while in some industries, like construction, where employment is intermittent, holding the elections presents serious administrative problems. Should the law be amended, in the interest of more efficient administration, either to prohibit all forms of compulsory membership in unions, or to eliminate the authorization by election requirement while retaining the other restrictions?"

There is no denying the fact that the requirement of an authorization election has put a temporary burden upon the National Labor Relations Board but that is scarcely sufficient reason for doing away with the requirement. Democratic processes are

[1] Report of the Joint Committee on Labor-Management Relations, Government Printing Office, 1948, p. 2.

[2] Editorial in *The Glass Cutter*, March, 1948, p. 1.

Contributed by the Management Division and presented at the Semi-Annual Meeting, Milwaukee, Wis., May 30–June 5, 1948, of The American Society of Mechanical Engineers.

rarely accomplished without effort. The fact that nearly all of the elections held so far have resulted in large majorities for the union proves nothing, except that in a few situations employees do not wish to be subjected to compulsory union membership. These results could also indicate that unions are only requesting elections in situations where they are sure of their ground. In any event, the issue becomes one of closing out the rights of those workers who do not choose the union shop.

Employer experience with the election requirement has been mixed but it is doubtful that a majority would be in favor of doing away with it. Once an election has been held and the question settled, the status can remain unchanged unless the bargaining representative or the unit changes or the employees petition for another election. To remove the election requirement would naturally remove this corresponding right of employees at some future date to petition for removal of the union shop.

Moreover, even in traditional union-shop industries, there are benefits to be derived from employee approval. The pre-election meeting usually clears up fuzzy issues on the unit such as the exclusion of the guards and supervisors, and the election is a wholesome experience in Democracy.

Employers in nonunion-shop industries protest because the election procedure strengthens the hands of union negotiators where there has been such a concrete indication of employee desires. This may be true but at least it does prevent the war of attrition usually waged by a union in such a situation until they have achieved a measure of union security.

The Minority Report of the Joint Committee on Labor-Management Relations emphasized that restrictions on closed- and union-shop contracts have resulted in "widespread resort to 'bootleg' contracts" in this field. If so, and a study of 100 union contracts indicated[3] that 14 were such that carrying out their provisions apparently would subject employers and unions to unfair-labor-practice charges, then this is all the more reason for the election requirement. If unions forced employers to sign "bootleg" agreements rather than risk a free election to determine the wishes of the group, then in those situations there is necessarily an implication that union membership is being imposed on those employees against their will.

SPEED UP NLRB DECISIONS

Another question is concerned with the administration of the Act, as follows: "What steps can be taken to speed up the handling of both representation and unfair-labor-practice cases to final decisions? Do the NLRB's interpretation of the noncommunist affidavit provisions, its refusal to apply the "free-speech" amendment to representation cases, and its failure to speed up its own procedures, indicate a trend which makes it advisable to transfer enforcement to the federal courts directly, or to some new labor courts?"

The Taft-Hartley Act provided for revisions in the organization and procedures of the National Labor Relations Board. The number of members was increased to five. These men have formed themselves into five panels of three each in order to expedite hearings. The Act abolished the so-called Review Section, but each member has from ten to fifteen legal assistants responsible to him personally.

The office of general counsel was created in order to take over administrative responsibilities. The intent is that the board shall confine itself, generally, to the functions of a court. Accordingly, there is some question as to whether very much would be gained in the matter of speeding up cases if the enforcement of the Act were transferred to the federal courts or to newly created labor courts. Court procedures are necessarily slow. The chief justification for administrative law in solving labor problems is that the subject requires all possible expedition in reaching a decision.

On the matter of interpretations of the law, a court might be expected to hand down more consistent decisions. On the other hand, much of the present difficulty with the board arises from the fact that a majority of the members apparently view the Taft-Hartley Act through eyes afflicted with Wagner-Act myopia. One of the members of the board is currently up for reappointment. If the Senate in its wisdom should decide upon the desirability of a fresh approach to problems arising under the Act, those problems might thereby be considerably lessened.

The "free-speech" amendment referred to is a section of the Act which provides impartially that the expression of arguments and opinions without threat of reprisal, or force, or promise of benefit is not to be considered an unfair labor practice. A glaring example of imbalance in labor relations was the fact that, under the Wagner Act, union representatives were free to make practically any statements they chose during an organizing campaign, whereas employers were rather effectively muzzled. Gradually, over a series of decisions, it seemed as though even the National Labor Relations Board was retreating from this hard and fast position.

In the General Shoe Company case, the board nullified an election the union had lost on the basis that the statute only protects an employer's speech against unfair labor charges. They reserved to themselves the right to overthrow an election whenever the employer might elect to utilize his rights granted in the Act. This approach is unrealistic in that the reason for the free-speech amendment was to permit an employer to present arguments relative to unionism during an organization drive. Now, whenever a union loses an election, the board can set aside the results. In effect, there is no longer free speech for an employer in an election case.

The board has construed the noncommunist affidavit provision in such a manner as to get around the apparent intent. This refers not only to the decision as to parent organizations but also to the determination that changing a union constitution so as to have only a few officers who need comply with the affidavit requirement, is acceptable. The official opinion expressed by the Department of Labor that the Act interposes no bar to bargaining with a nonfiling union further made strict enforcement unlikely.

Many employers have continued to negotiate with noncomplying unions with which they have had previous contractual relations if they believed such unions still represented their employees. They have done this on the basis that it is sound labor relations to continue to bargain with the union which actually represents a majority of the plant's employees, even though the law does not require such bargaining in the case of a noncomplying union. The noncommunist affidavit requirement of the Act is helping employers to the extent that it allows an employer the opportunity to come out in the open against an unsatisfactory situation. The Caterpillar Tractor strike was an example, and there are others.

If all employers refused to deal with all noncomplying unions, we would have a strike wave of such proportions that the economy as well as the defense and ECA programs could well be jeopardized. On the other hand, a necessary ingredient of the Taft-Hartley Act is courage on the part of the employer and, if the problem is ignored, therefore, it can be expected that Congress will make even more stringent regulations. Each employer must necessarily make his own decisions based upon the hard facts of his own particular situation.

A number of board decisions over the past ten months have pointed in a direction opposite to that apparently contemplated

[3] "Union Security Clauses Since Taft-Hartley Act," *The Management Record*, February, 1948, p. 55.

by the Act. A series of decisions has operated almost to the point of nullifying the right of employees to have a union decertified. In the Underwriters Salvage Company case, the board granted permission for withdrawal of such a petition. This may result in tremendous union pressure upon any employee who files in the future. In the Spencer Cardinal Corporation case the board decided that in a three-plant bargaining unit, a petition could not be filed to decertify one plant. This is inimical to the exercise of the right because it becomes almost impossible for a single employee to obtain a 30 per cent backing in a multiplant or industry-wide bargaining unit. In two other cases, the board refused decertification proceedings to employees of companies which were accused of refusal to bargain.

The board's decisions requiring bargaining on pensions, as well as the one extending their jurisdiction to retail stores have not been easy to take. It is necessary to remember, however, that the Wagner Act received its meaning from some 15,000 formal decisions and orders of the National Labor Relations Board. It would seem much too early to advocate direct enforcement of the Act by the courts. The board now has broad interpretative powers. If future decisions are adverse to the fundamental rights granted in the Act, then Congress should consider a change in enforcement procedure.

QUESTIONS OF NATIONAL EMERGENCY

The next question involves the efficacy of the Act in dealing with national emergency situations. The problem is stated, "How should the law's provisions regarding industry-wide bargaining and stoppages be strengthened to meet, for instance, the current threat of a railroad strike, or the situation if the present eighty-day injunction period fails to bring about a settlement in a basic industry like coal or steel? Possible approaches to the fundamental problem, which is the concentration of economic power that industry-wide bargaining inevitably develops, are strict regulation such as compulsory arbitration or seizure in the public interest, or applying the antitrust-law principle of breaking up the concentration of power on both sides of the bargaining table."

The Act attempts to deal with national emergency situations in the most democratic manner possible. Reliance is made upon investigation, public opinion, and a secret ballot vote of the employees concerning the employer's last offer. If all these fail and no settlement is reached, the President is required by the Act to submit to Congress a full and comprehensive report of the proceedings, including the findings of the board of inquiry and the ballot taken by the National Labor Relations Board, together with such recommendations as he may see fit to make for consideration and appropriate action.

The only alternatives, as indicated, are compulsory arbitration, seizure in the public interest or breaking up the bargaining units. Compulsory arbitration inevitably leads us along the pathway to labor courts. Only when there is security of tenure and freedom from political influence can decisions be expected to be unassailable. There is question as to whether we are ready for labor courts as yet, although the trend of thinking appears to be moving in that direction. The so-called fact-finding boards of several years ago which made recommendations were a sort of compulsory arbitration because there was public pressure to accept their findings. Dissatisfaction with this type of procedure would indicate the unlikelihood of imminent compulsory arbitration.

Seizure in the public interest has definite limitations. There is no question of the public interest in the X-10 Atomic Plant at Oak Ridge, Tenn., yet the question of a strike was recently before us. The various crises in coal have not indicated the unqualified success of government seizure unless accompanied by government concessions. This type of solution may be successful in isolated emergencies but it is scarcely suitable as a general remedy.

There has been talk of a congressional proposal to outlaw industry-wide bargaining and nation-wide strike weapons. A serious national emergency apparently impossible of solution could easily result in such legislation. It is based on the premise that the country can stand a series of small strikes but that when an entire basic industry is shut down the whole economy is threatened.

A breaking up of collective-bargaining units would bring with it many ancillary problems. It is often forgotten that much multiunit bargaining occurs because small companies are powerless against large unions. We have as an example of such a situation one of the most serious problems which the Taft-Hartley Act administration has encountered; that is, strikes or threats thereof against small employers to force a violation of the provisions of the law. Unions are wealthy and powerful, and the small employer usually finds himself at a disadvantage in bargaining.

Moreover, if the unit is broken up, will the union monopoly also be broken up? If not, there is no use telling employers they can hire whom they wish or discharge employees under certain circumstances. In coal, for example, where would an employer get his men? And what about the so-called "standard" contracts used by some unions and presented to small employers ready for signature, or the requirement of national union approval in order to validate a local agreement? There may be some advantages to breaking up large bargaining units, but there are numerous problems that will need to be solved first in order to maintain an element of balance in the union-management relationship.

UNION WELFARE FUNDS

The question of union welfare funds is stated as follows: "What is a sound permanent solution to the problem of union welfare funds? The NLRB recently ruled that employers must bargain on welfare funds, and some unions have prevailed on employers to make initial contributions to welfare funds in existence prior to January 1, 1946, thereby avoiding the restrictions of the Taft-Hartley Act, while there is grave doubt as to the actuarial soundness of some such funds. Is a jointly administered welfare fund desirable or workable, particularly where a large employer may deal with a dozen or more different unions?"

A welfare fund controlled or dominated by union leaders could become more powerful a force than the closed shop for the control of members. If welfare funds are to be allowed at all, it becomes necessary in the public interest to limit their use.

Arbitrators have made awards in several cases involving interpretation of this section of the Act. In the Harjer Furniture Company case the arbitrator ruled in effect that the Act provides a perpetual exemption from the requirement of equal representation in the administration of the trust to funds established prior to January 1, 1946. The award held that an employer who agreed to contribute to a fund established prior to January 1, 1946, and to which he was not a party, could not raise the issue of equal representation. A similar award was handed down involving the Association of Uptown Converters.

These awards have handed unions a subterfuge by which they can avoid the restriction of joint representation merely by causing employers to allocate contributions to funds which were in existence before January 1, 1946.

There is no gainsaying the fact that union welfare funds are here. They are considered necessary in certain circumstances where a union bargains with many small financially unstable employers. The issue of whether an employer must bargain on

(*Continued on page 767*)

BRIEFING THE RECORD

Abstracts and Comments Based on Current Periodicals and Events

COMPILED AND EDITED BY J. J. JAKLITSCH, JR.

MATERIAL for these pages is assembled from numerous sources and aims to cover a broad range of subject matter. While few quotation marks are used, passages that are directly quoted are obvious from the context and credit to original sources is given.

Atomic Aircraft Engines

ATOMIC energy as a source of power for aircraft promises to achieve a result unobtainable with standard fuels, according to an article by Andrew Kalitinsky, chief engineer of the NEPA (Nuclear Energy for the Propulsion of Aircraft) Division of Fairchild Engine and Airplane Corporation, in *The Pegasus*, August, 1948. Such airplanes would combine extremely high speed with almost unlimited range. This application of nuclear energy may eventually make possible a supersonic bomber capable of flying around the world without pausing to refuel.

The development of atomic power for aircraft is not a simple undertaking but there are several basic types of power plants that can be adapted to utilize this power for the propulsion of aircraft. They are all thermal power plants, since fission energy is released predominantly in the form of heat.

One application of atomic energy is in the turbojet. The combustion chamber of the conventional turbojet is removed and replaced with a nuclear reactor. Air is compressed and forced through the reactor, where it is heated by convection instead of by combustion of fuel. It then expands partially in the turbine, enough to provide sufficient power to drive the compressor, and finally in the jet nozzle where it creates propulsive thrust. This type of power plant is very well suited to high-speed airplanes.

On paper, the ramjet is the simplest type of power plant conceivable. Air enters the diffuser at the front end of the engine and is compressed by the forward speed of the airplane. It then passes through the nuclear reactor, where it is heated to a high temperature, and goes into the exhaust nozzle, where it expands and acquires a high velocity to provide thrust. The ramjet requires a high flight speed to function at all and becomes really effective at extreme speeds high in the supersonic region. The air temperatures required by the ramjet are very high, considerably higher than those needed by the turbojet. At the same time, the ramjet is very sensitive to pressure drops caused by the internal flow resistance of the reactor or combustion chamber. Good heat-transfer conditions must always be paid for by appreciable pressure drops. The ramjet is therefore not quite the simple problem it appears to be at first glance.

In the application of nuclear energy to a rocket, a propellant (liquid hydrogen, for example) is pumped out of the tank and through the reactor, where it is vaporized and heated to a high temperature. It then escapes at high velocity through the exhaust nozzle. The rocket is driven by the recoil of the escaping propellant and thus is not dependent on atmospheric air for its functioning. It can therefore operate outside the earth's atmosphere.

Nuclear energy offers a definite advantage in rockets because the maximum impulse, the pounds of thrust that can be obtained from each pound of fuel used per second, results from a combination of the highest possible temperature and the lowest possible molecular weight of the fuel.

Many of the problems which lie in the path of the practical realization of atomic aircraft power plants are connected with the use of high temperatures.

The temperature problem is aggravated by the heat-transfer problem. The great advance in lightweight design, which made the automobile and airplane possible, came to pass when it was learned how to avoid transferring heat through walls as in a boiler; in other words, with the advent of internal combustion.

In a nuclear engine, the heat is generated in the solid portions of the reactor and must be transferred to the working fluid through heat-transfer surfaces.

One basic fact remains, however, and that is that the internal surfaces of the reactor must be at a temperature higher than the highest temperature of the working fluid, since heat must flow from the reactor into the fluid. It can only flow if there is a positive temperature difference. This is very different from the internal-combustion engine where, as in the automobile, the cycle temperatures reach 4000 F while the internal surface temperatures can be kept down to around 500 F by external cooling. On the other hand, there are no moving parts in the reactor and the reactor elements are not subjected to the high dynamic stresses which are encountered in such parts as pistons, valves, or turbine buckets. It can be said broadly that the temperatures necessary for the realization of

How to Obtain Further Information on "Briefing the Record" Items

MATERIAL for this section is abstracted from: (1) technical magazines; (2) news stories and releases of manufacturers, Government agencies, and other institutions; and (3) ASME technical papers not preprinted for meetings. Abstracts of ASME preprints will be found in the "ASME Technical Digest" section.

For the texts from which the abstracts of the "Briefing the Record" section are prepared, the reader is referred to the original sources, i.e.: (1) The technical magazine mentioned in the abstract, which is on file in the Engineering Societies Library, 29 West 39th St., New York 18, N. Y., and other libraries. (2) The manufacturer, Government agency, or other institution referred to in the abstract. (3) The Engineering Societies Library for ASME papers not preprinted for meetings. Only the original manuscripts of these papers are available. Photostat copies may be purchased from the Library at usual rates, 40 cents per page.

an atomic engine are not unreasonable from the metallurgical standpoint, but they do nevertheless engender a number of difficult problems.

One of these problems is the protection of the uranium in the reactor against corrosion by the working fluid and, conversely, the prevention of the escape of the radioactive fission products from the reactor into the working fluid. This is a problem of diffusion and diffusion rates generally go up with increasing temperature. The development of adequate canning for the high-temperature reactor elements is therefore a major problem.

Another crucial problem, as in any aircraft, is weight. In an atomic engine, it is necessary to use large amounts of mass to stop radiations emitted during the fission process. In a conventional airplane the weight of the propulsion system comprises substantially three major items: the power plant proper, the fuel, and the fuel tanks. In the nuclear aircraft, these correspond to the "engine" (compressor-turbine assembly in a turbojet), the nuclear reactor, and the shielding.

The engine component of the nuclear installation may be expected to weigh approximately the same as a conventional power plant of the same horsepower or thrust rating. The weight of reactor and shielding is therefore equivalent to the weight of the fuel and fuel tanks in a chemically fueled aircraft.

The percentage of the airplane gross weight which can be allotted to fuel and fuel tanks, or to reactor and shielding, depends primarily on the structural refinement of the airplane. In present-day long-range airplanes, it represents a very high percentage of the gross weight and is, in some cases, well in excess of 50 tons.

Shielding weight is influenced about equally by two entirely separate variables. One is the size of the reactor core around which the shielding must be wrapped. The other is the thickness of the shielding itself or, more precisely, the mass thickness needed to stop gamma rays and neutrons emitted by the fission process.

Making the reactor small is an obvious way of reducing weight of shielding. However, it means releasing energy at a high rate in a small volume. Although a nuclear reactor can potentially generate heat at a practically unlimited rate, this heat must be conducted from the interior of the fuel rod to its surface. It must then be transferred from the surface to the working fluid, meaning high temperature differentials, high pressure drops, large internal surface areas, and all other difficulties associated with high power densities. Furthermore, the smaller a reactor is, the larger the ratio of its surface area to its volume and the easier it is for neutrons to escape without causing new fissions. A smaller reactor may therefore require a larger investment of uranium in order to sustain the chain reaction and this may prove undesirable from an economic standpoint.

The atomic-powered airplane must be designed for very high speeds to take advantage of the special characteristics of atomic power. It certainly will be a large airplane. It will have to be designed for a landing weight which is equal to take-off weight, since practically no fuel will be used up in flight. Because of radiation, the crew locations should be placed as far away from the power plant as possible. That would permit some weight saving in the shield.

Structural requirements will be somewhat different from those of conventional airplanes, since the fuel load will be concentrated in one spot in the reactor, rather than widely distributed. In this respect, however, the atomic airplane may not differ much from some of the thin-winged, high-speed airplanes now under development which do not use wing tanks.

Naval Research Laboratory

THE U. S. Navy recently dedicated the new Michelson Research Laboratory at the United States Naval Ordnance Test Station, Inyokern, Calif. Named in honor of the late Dr. Albert A. Michelson, noted American physicist and Nobel Prize winner, the laboratory is said to be the most complete scientific research facility of its type in the world.

The laboratory is virtually self-sufficient. Air-conditioned and earthquake-resistant, it contains extensive facilities for all types of basic and applied research in the fields of physical and chemical science, aerophysics, mathematics, electronics, metallurgy, propulsion systems for rockets and missiles, and fire-control and guidance systems. Its machine shop is capable of handling work ranging from heavy metal tooling to manufacture of complicated parts of extremely delicate instruments.

Still under construction in the laboratory are the all-weather and altitude testing rooms. Here the Navy will be able to produce custom-made weather at will, simplifying the testing of new weapons under simulated atmospheric conditions, such as sandstorms, icing, rain, salt spray, wind, altitude changes, or any combination of the foregoing.

Atomic Research

ACCORDING to a recent announcement, a new Research Building at the Ames Laboratory, Iowa State College, Ames, Iowa, of the United States Atomic Energy Commission will be constructed west of the new Metallurgy Building, which was started recently. The Research Building will be a four-story concrete structure 240 × 60 ft with a two-story wing 120 × 40 ft. It will cost about $1,500,000 with an additional $350,000 for equipment.

The new Research and Metallurgy Buildings represent an investment of slightly more than $3,000,000 by the U. S. Atomic Energy Commission in construction and equipment. When both structures are completed, most of the various phases of the Commission's program at the Ames Laboratory will be consolidated, thus increasing efficiency of the research operations and stepping up the training of young scientists in atomic-energy fields now critically short of experienced technicians.

The research carried on by the Ames Laboratory is of importance both in the expansion of fundamental knowledge related to atomic energy, and in the development of materials and processes used in the production phases of the nation's atomic-energy program.

Nevis Cyclotron

THE Columbia University Physics Department's 2500-ton synchrocyclotron, which is nearing completion at Columbia's Nevis estate at Irvington-on-Hudson, N. Y., will be ready to attack a ten-year program of nuclear research shortly, according to an article by Charles Ferstenberg, in the *Columbia Engineering Quarterly*, May, 1948.

The Office of Naval Research, through a grant, has supplied funds for the 2200-ton magnet and auxiliary equipment of the cyclotron, while Columbia's own share of the project came to $550,000.

The cyclotron will make it possible to accelerate a stream of protons to the unprecedented energy of 400 million electron volts. With these large energies available it is hoped to supply the answers to several puzzles, among which are a number of unexplained phenomena observed during wartime nuclear re-

search. The biggest problem facing the Columbia group is to study the rather elusive meson, in an attempt to throw light on internal nuclear forces.

Since it is the most powerful one in the world, this cyclotron presented difficult problems of design, construction, and transportation for the Columbia scientists. The present design of the 2200-ton magnet, for example, developed after an extended series of model tests by the Columbia group, was executed by the Bethlehem Steel Company, Bethlehem, Pa. Since the plates were fashioned from ingots weighing about 460,000 lb, the rolling methods used in working ordinary plates were inadequate, and the soft low-carbon, steel plates were all shaped by 7500-ton steam-hydraulic presses with the metal at temperatures close to 2000 F.

The yoke of the magnet is built up of these heavy plates bolted together, 10 plates weighing 60 tons each in the top, 10 similar plates in the bottom, and five 38-ton plates in each side section. The poles are built up of cylindrical plates $13^1/_2$ ft in diam; first two 47-ton plates, then a 43-ton shouldered plate, and finally two sets of pole-tip plates, 6 and 8 in. thick, respectively. The rectangular yoke stands 21 ft high, 33 ft long, and about 14 ft wide, with an opening to receive the pole pieces measuring $22^1/_2 \times 10^1/_2$ ft.

The cyclotron has a frequency-modulated electric field (of about 25,000 volts) because the alternating potential of the accelerating electrodes in an ordinary cyclotron, which vary regularly, work satisfactorily only until the charged particle has attained an energy of about 30 million electron volts. At about this point relativity considerations of the particle's mass make it necessary to vary the resonant frequency to keep step with the rotating particle. The radio-frequency circuit is of a self-excited oscillation type. Self-controlled capacitances on each of the "Dees," i.e., on each half of the acceleration chamber, modulate the frequency at a rate of 120 times per sec between about 17 megacycles per sec and 27 megacycles per sec.

Steam Power Stations

A DIGEST of the practices and opinions of American steam-power-plant designers and station operators was presented by A. G. Christie, Hon. Mem. and past-president ASME, professor of mechanical engineering, Johns Hopkins University, Baltimore, Md., as one of the centenary lectures given at the one-hundredth anniversary celebration of The Institution of Mechanical Engineers. The paper appears in The Institution of Mechanical Engineers Proceedings, vol. 157, 1947 (War Emergency Issue No. 29).

According to Professor Christie, reliability and availability of equipment are given preference over high thermal efficiency in plant design, and this accounts for the success of higher pressure and temperature stations.

Many stations were designed for 850 psig and 900 F at the turbine throttle, as studies indicated these conditions led to the most economic performance. Plants with 1250 psig and 950 F, have given excellent service. Several plants operate at still higher pressures. Increasing fuel and labor costs justify the added investment for high pressures to reduce operating expenses. Temperatures up to 1050 F with 1250 psi will be used in some stations now planned.

The combination of furnace, boiler, superheater, economizer, and air preheater is known as the "steam generator." Improvements in design and operation of recent steam generators have resulted in substantially the same availability as of turbine-generators and condensers. Many units operate continuously for long periods without a break. Unit systems with a single large steam generator per turbine are becoming universal practice. Labor and maintenance costs as well as investment are thus reduced. Automatic controls for all equipment are becoming standard. Few plant operators are required but these have high intelligence to insure close technical control.

Boiler designs aim to take full advantage of the effectiveness of radiant-heat transfer. Dry-bottom furnaces are favored as these can operate satisfactorily over a wide range of load.

Steam-generator efficiencies, depending on fuel and heat-recovery equipment, vary from 76 to 90 per cent based on higher heat values of fuel.

Convection tubes and tubes in high-temperature superheater sections are widely spaced to avoid slagging. Drums are of welded construction with joints annealed and x-rayed after welding. Tubes are rolled into drums and headers. Seal-welding of tubes is increasing and will probably lead to complete tube-welding instead of tube-rolling. Devices in the steam drum, such as feedwater steam washers, cyclone separators, and steam driers, prevent carry-over of solids.

Superheaters are usually of the multiple-loop type. Drainable and nondraining units give equal satisfaction. High-temperature sections have tubing of 3 to 6 per cent chromium, with 0.5 per cent molybdenum fort emperatures 800 to 950 F and 18–8 stainless steel stabilized by columbium for 950 to 1050 F.

While oil and natural gas are burned in some stations, the majority of steam plants burn coal. Direct firing of pulverized coal has superseded the earlier bin and feeder system. Coal pulverizers of the impact, ball, bowl, and tube-mill types are in use. Each type has specific advantages under given local conditions. A new form of flash pulverizer using compressed air has been developed and has possibilities for power-plant use. A form of cyclone furnace using only crushed coal is operating in a Chicago central station.

Economizers are built-in elements of the steam generator. Steaming economizers are now seldom installed. Regenerative air preheaters (Ljungström type) heating to 500 to 600 F, are compact and fit into many plant layouts.

Large boilers, and many smaller ones, operate under automatic regulation of fuel and air, for which several control systems are available.

Many multistage, centrifugal, boiler feed pumps have horizontally split casings, but joint troubles have led to the adoption of the barrel-type pump. This pump with its inner horizontally split casing is placed in an outer barrel-shaped casing. Full discharge pressure between the two casings insures a tight horizontal joint. Feed-pump efficiencies range from 70 to 78 per cent. Such pumps have continuously sloping head-capacity curves. Owing to the corrosive action of high-temperature feedwater, alloy casings with 4–6 per cent chromium, or even with 18–8 stainless steel, are now used. These pumps are generally driven by constant-speed motors with a steam-driven unit for emergency reserve. By-pass devices are provided on the discharge to insure sufficient flow to protect the pump at light loads. The supply of boiler feedwater is automatically controlled.

Feedwater treatment is a major factor in steam-plant operation. In condensing plants the make-up water of $^1/_2$ to 2 per cent is generally provided by an evaporator incorporated in the feed-heating cycle. Raw water is often softened by zeolite or lime-soda processes, heated, and deaerated before entering the evaporator which thus remains in service for long periods without cleaning. Chemicals are added to the feedwater or boiler water to control internal conditions. An excess of sodium sulphite is maintained in the boiler to absorb residual oxygen. Caustic soda provides the desired alkalinity which, with high pressures, requires a pH of about 11.6. Sodium sulphate is added to maintain the proper sulphate-

alkalinity ratio to inhibit caustic embrittlement. An excess of trisodium phosphate prevents the deposition of any residual scale-forming compounds. Special pumps feed these solutions under controlled conditions into the feedwater system or into the boiler. Boiler operation over long periods is secured by careful checking of the boiler water many times daily and the adjustment of treatment and blowdown to maintain the desired conditions. Feedwater in industrial plants may consist of 100 per cent make-up if exhaust steam is used in process.

Natural gas is delivered directly from pipe lines to simple burners. Fuel oil is stored in tanks outside the plant from which it is pumped through heaters to mechanical or steam-atomizing-type burners.

Coal may be delivered by rail or boat and is unloaded by car dumpers, drop-bottom grab buckets, and other devices. After passing through hammer mills, crushers, or Bradford breakers, it is conveyed to storage by belt conveyers in large plants, or by skip hoists or other elevators in smaller plants.

Large turbine-generator units operate on the regenerative cycle with three to five points of extraction, depending on economizer and air-preheater design, and the cost of coal. Some of the older stations operate on the reheating cycle.

Topping or superposed high-pressure turbines have been installed with high-pressure boilers to improve the performance of numerous older stations.

The National Electrical Manufacturers' Association has adopted a series of standard sizes for condensing turbines with ratings from 500 to 7500 kw.

A joint committee of The American Society of Mechanical Engineers and the American Institute of Electrical Engineers has adopted standards for 3600-rpm turbines of more than 10,000 kw.

The standard frequency in America is now 60 cycles. Turbines are available at 3600 rpm up to 80,000 kw, with double-flow low-pressure cylinders, and with limiting blade lengths of 23 in. on a 42.5-in. disk, and maximum tip speeds of 1390 fps. Units are built up to 165,000 kw at 1800 rpm, with double-flow exhaust, and maximum blade lengths of 40 in. on an 80-in. disk, with resultant blade-tip speed of 1256 fps.

Nozzle governing with an impulse first stage is common on large turbines and on many smaller ones. Very small units are generally throttle-governed.

Most turbines have water-sealed glands where shafts leave casings to prevent steam leakage into the turbine room.

All alternators rated at 20,000 kw and larger are hydrogen-cooled, with hydrogen pressures ranging from 0.5 to 15 psig and with equipment to free hydrogen from sealing oil.

Surface condensers are designed for distribution of exhaust steam to every part in proportion to its condensing capacity. Moisture in exhaust seldom exceeds 12 per cent. A minimum pressure drop between exhaust inlet and air-pump suction is obtained by proper tube spacing. Tube arrangements are not standardized; nor is there any uniform practice in the removal of condensate from tube surfaces. Hot wells with provision for reheating and deaeration are now standard.

Standards have been established for all piping and fittings. Piping is welded throughout, welds being annealed in place by electric heaters. Low-carbon steels are used for water and low-pressure steam piping. Heavy piping needed for high steam pressure requires extensive bends between steam generator and turbine to care for expansion with high temperatures. Combined stresses and thrusts in such piping are carefully calculated and proper anchorage provided. Bolt failures in valve bonnets and elsewhere have been overcome by better thread-and-bolt design using alloy steels.

Canadian Jet Engine

CANADA'S first jet engine, the "Chinook" gas turbine, designed and built for the Royal Canadian Air Force by A. V. Roe Canada Limited, Malton, Ontario, has been successfully test-run, it was announced recently.

The Chinook is a gas-turbine engine, consisting of a nine-stage axial-flow compressor, six combustion chambers, a single-stage turbine, and an exhaust tail cone.

In operation, air is first drawn into the engine by the compressor which is made up of nine stages, each stage or row of whirling blades compressing the air a little more until at the end of the ninth stage it has been compressed to about $4^1/_2$ atm, or 50 psi. This compression also heats the air to about 400 F.

The air at this point is forced into the combustion chambers placed around the engine. Kerosene fuel is pumped into this compressed air in the form of a spray, and burned continuously somewhat in the manner of an oil furnace. A spark plug is used to ignite the mixture when starting. Only a small portion of this air is used for combustion, but the tremendous heat generated expands the main volume of air passing through the combustion chambers.

Since the combustion chambers have an open end, the pressure does not build up, but the heated air and burned gases, because of their rapid expansion, force their way at high speed between the blades on the turbine disk causing the turbine wheel to rotate at about 10,000 rpm at full speed. This energy is transmitted by the turbine shaft to the compressor, which, in turn, compresses more air into the combustion chamber, and the action then becomes continuous so long as fuel is fed into the combustion chambers.

There is one row of blades, or one stage, in the turbine wheel,

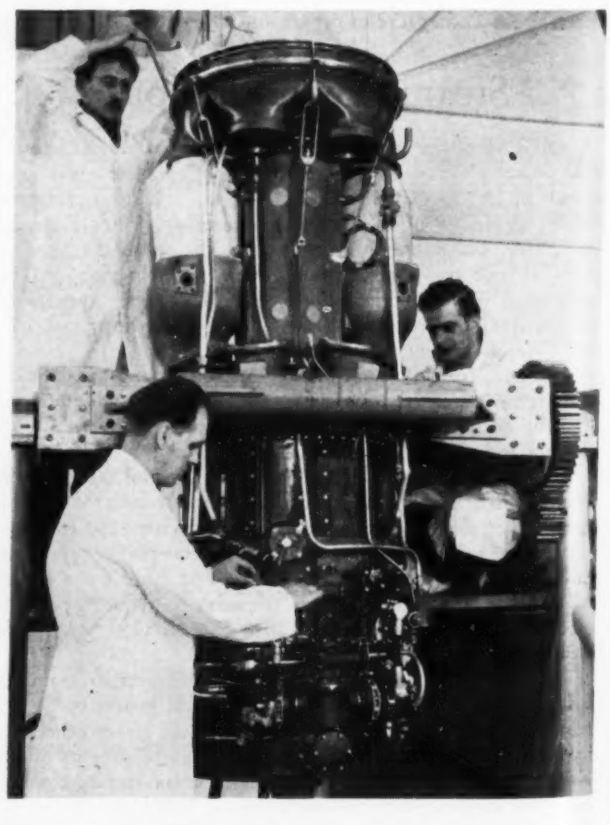

FIG. 1 CHINOOK JET ENGINE IN FINAL ASSEMBLY STAGE

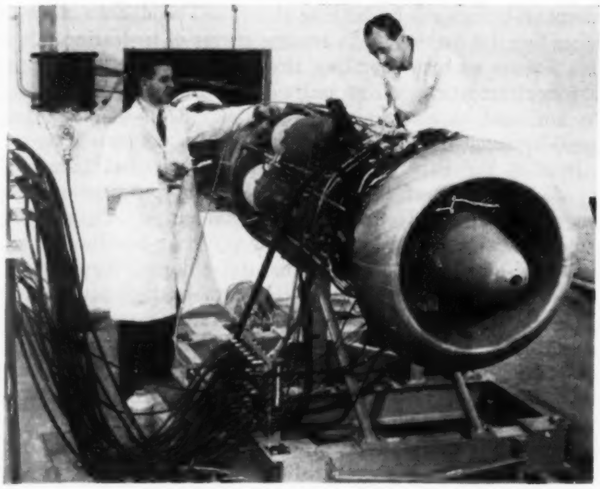

FIG. 2 CHINOOK ENGINE ON TEST STAND

which is all that is required to drive the nine-stage compressor and the engine auxiliary equipment.

The air, or hot gases, passing from the turbine are still expanding, and leave the rear end of the engine at about 1200 mph.

For starting the engine, an electric motor located at the front is connected to the compressor and runs it up to about one-eighth engine speed until sufficient air is being pushed through for combustion purposes, at which time the fuel is introduced.

The thrust power developed by the engine is equivalent to about 25 large automobile engines each delivering 100 hp, yet it weighs only 1250 lb. It is 32 in. in diam, 125 in. in length, and it has a frontal area of 5.59 sq ft.

The nine-stage axial-flow compressor is preceded by precision-cast aluminum-alloy inlet guide vanes, and discharges the air directly into the combustion chambers through six diffusers. The first two stages of rotor blades are stainless steel; the remainder aluminum alloy. The rotor is supported in a self-aligning antifriction bearing at the front end, and a duplex-type ball bearing in a self-aligning mounting at the rear.

The combustion system consists of six interconnected straight-through combustion chambers discharging into a fabricated nozzle box, each chamber consisting of an outer air casing and an inner flame tube.

The turbine rotor comprises an alloy-steel disk with an integrally forged stub shaft, and chrome-nickel-alloy rotor blades fastened to the rim with fir-tree roots. Cast chrome-cobalt nozzle guide vanes are used. The front end of the turbine shaft connects directly to the rear of the compressor rotor through a flexible coupling designed to compensate for angular misalignment.

The tail cone is fabricated from stainless-steel sheet with cast flanges at front and rear, and is insulated by glass-wool blankets encased in silver-foil shields under a sheet-aluminum outer covering.

The fuel system comprises two Lucas variable-delivery positive-displacement pumps, one flow-control unit, a pressure-regulating valve, six burners, a combined solenoid and torch-igniter reducing valve, and two torch igniters.

A dry-sump lubrication system is used which incorporates a multiple-type pump consisting of one pressure and two scavenge elements. The two scavenge pumps draw oil from the front and rear main bearings, with the center bearing drained by gravity both fore and aft. An oil tank, oil filter, and pressure regulator complete the system.

A direct-drive electric motor is used for starting the engine from a 24-volt direct-current supply.

Pressure Blast Furnace

THE potentialities of the pressure blast furnace are discussed in an article by B. S. Old and E. R. Poor, Arthur D. Little, Inc., in the July, 1948, issue of *Mining and Metallurgy*. It is revealed that experiments consisting of operating a blast furnace at higher-than-normal top pressures, as proposed by Arthur D. Little, Inc., were carried out by the Republic Steel Corporation initially during World War II and much more extensively during the past twenty months. The results of the Republic trials indicate that pressure blowing is a solution to the problem of increasing pig-iron capacity without necessitating major changes to existing equipment.

If the top pressure in a blast furnace is increased by throttling exhaust gases, the result is an increase in the average static pressure through the furnace, which decreases the volume and increases the density of the gases passing through the stack. Thus it is possible to blow a greater-than-normal amount of wind through the furnace before a critical gas velocity is reached, above which furnace operation is impractical because of excessive flue-dust production, slipping, and channeling. Since iron production varies directly with wind volume blown, an increase in the average static pressure, which makes possible increasing the amount of wind blown, results in an increase in the tons of iron produced. By blowing large volumes of wind at lower-than-normal gas velocities, a more uniform pattern of gas flow in the working volume of the blast furnace results, and, in addition, there is longer time for contact between reducing gas and ore. In other words, the gas is used more efficiently, thus enabling the furnace to carry a higher burden ratio which is reflected in a lower ratio of carbon monoxide to carbon dioxide in the top gas.

Results of the experiments by the Republic Steel Corporation are said to have confirmed the theories of pressure operation, in that, iron production has been increased 11 to 20 per cent per day with a 13 per cent decrease in coke rate per ton of pig and a 30 per cent reduction in flue-dust production. A manufacturing cost saving of more than $1 per ton of iron has been realized. These results are being obtained while operating at an average top pressure of approximately 10 psi. Turboblowers will soon be delivered which will make possible the operation of a blast furnace at 20 psi top pressure. Calculations indicate that results at this higher pressure should be even more startling when compared to normal operating production and cost figures. One new blower which was to be delivered to the Warren plant of Republic in April or May was of 125,000 cfm, 40 psi capacity, the largest blast-furnace blower in the world.

Although initial trials were hampered by minor mechanical difficulties, new devices, occasional alterations, and general experience have eliminated any problems peculiar to pressure operation.

No major changes in the design of a modern blast-furnace plant are said to be necessary to permit pressure operation. The minor alterations consist of the installation of a throttling valve to regulate pressure, a clean-gas system for equalizing furnace top pressure with the hopper pressure when dumping the big bell, and a one-piece hopper and hard surfacing for both bell and hopper seats. The new devices are either equipped with new mechanical operating controls or are tied into existing systems, and once installed, require little attention and low maintenance. No additional personnel are required to operate a pressure furnace. One of the major features of this new method of operation is the relatively small financial outlay necessary to

convert a modern plant to pressure operation. Recent estimates on existing furnaces have indicated that the conversion can be made for as little as $120,000 for materials exclusive of any additions or alterations to existing blowing equipment.

Out of a total of 245 furnaces now in blast in this country, approximately 80 or 32.6 per cent could be converted to permit operation at 10-psi top pressure with existing blowing facilities. This estimate is based on present blowing equipment as estimated in the Iron and Steel Works Directory for 1945 and on information obtained from turboblower manufacturers regarding their recent installations. It has been assumed that a blast-furnace plant equipped with 30-psi blowers of adequate capacity can be operated at approximately 10 psi top pressure. Regardless of the fact that some furnaces might not have the maximum wind capacity required, it would still be advantageous to convert because, although maximum iron-tonnage increases would not be realized, coke saving, less flue-dust production, and smoother operation would result.

In addition to the iron blast furnace, it appears that the principles of pressure blowing may be applied to nonferrous-metal smelting, as carried out in the copper or lead blast furnace. Development of a suitable means of charging the furnace under pressure to replace the existing pusher and raised-door method seems the only major alteration necessary. Although little improvement could be expected over the present low fuel rate, a pronounced decrease in dust and fume production would result from the lower velocities of pressure operation. Increased metal production should also be realized because more wind volume can be blown at any given wind velocity. Any predictions for the nonferrous blast furnace would necessarily be theoretical because of the lack of experimental data. Thought has also been given to the operation of cupolas under increased pressure.

Resin Bonding

THROUGH the use of a synthetic resin which imparts unusual strength to paper, vast amounts of wood which have been of little use in the production of paper can now be added to the nation's critical supply of satisfactory pulp timber. This new technique in papermaking is said to combine superior dimensional stability with high strength, when using the ordinary commercial wood pulps, and also makes it possible to produce suitable papers from relatively abundant wood species not now fully utilized. The development, growing out of a comprehensive research program at the National Bureau of Standards on offset printing papers, thus points to improved products and the conservation and extension of critical raw materials supplies. Furthermore, it does not involve either appreciable increase in costs or any important change in manufacturing methods.

Deciduous woods such as the maple, beech, birch, or poplar have until now been used only as "filler" in the manufacture of high-grade printing paper. In 1946, for example, wood of this type accounted for only 16 per cent of the pulp consumed and in inventory. No matter how desirable their other characteristics may be, the deciduous woods do not produce the primary qualities of strength and resistance to surface pick, in the usual methods of processing. The development of strength through the use of the synthetic resin, melamine formaldehyde, will have the effect of materially increasing the use of the short-fibered pulps.

The new technique consists essentially in substituting synthetic-resin bonds between the fibers for the gel-like bonds formed by hydration. The resin bonding gives optimum strength with only a fraction of the beating required to develop comparable strength by beating alone, and produces a superior paper by elimination of the adverse effects of hydration. It is this feature of resin bonding that makes possible the satisfactory sheet strength from pulps of the deciduous woods that do not lend themselves to hydration. Resin-bonding thus opens up an entirely new reservoir of fibrous raw material.

In 1944 the Paper Laboratory of the National Bureau of Standards developed a high-wet-strength paper primarily for war maps, but made from conventional pulps. The unusual strength was acquired by substitution of resin bonding for the usual gel-like bonds occurring naturally during manufacture. The present development, involving experimental manufacture on a semicommercial scale, is essentially an extension of this work to the short-fibered pulps that possess every characteristic needed for good printing paper except the important one of strength. Widely different combinations of commercial wood pulps were investigated to determine the advantages of resin-bonding in printing papers. A series of papers was made from each combination with controlled variations in beating, with and without synthetic-resin bonding. In all instances, the resin-bonded papers were superior with respect to curling, oil absorption, folding endurance, resistance to surface pick, and expansivity. Several types of synthetic resins have been used, with melamine-formaldehyde resin giving the best results to date. Surprisingly small amounts of this resin are required, usually less than 3 per cent by weight.

With the United States using more paper than ever before in its history and the wood pile getting smaller, this new method should aid in making larger stocks available and provide another economic use for the nonconiferous trees.

Report on Japan and Korea

THE report of the "Johnston Committee" which recently visited Japan and Korea to study the economic position and prospects of those countries and measures required to improve them has been released recently by the Department of the Army. Percy H. Johnston served as chairman of the committee.

According to the report, the Committee has been greatly impressed with the complete demilitarization of Japan and with the progress made in developing representative government in that formerly feudalistic country. A thoroughly democratic constitution has been adopted and an elected Diet, or Parliament, is actively functioning. Unlike the situation in Germany and Korea, Japan is not cut up in separate zones of occupation, and a Japanese government is actively dealing with the daily problems of its people. The Japanese people themselves seem to be fully co-operating with the occupation authorities.

The United States has been paying the military costs of occupation and in addition, under its international law obligation as occupying power to prevent disease and unrest, has been furnishing food and other relief supplies to keep the Japanese people alive. These relief costs run to nearly $400,000,000 a year.

Japan has been shorn of its empire and has been expelled from China, Manchuria, Korea, and Formosa, southern Sakhalin, the Kurile, Marshall, and Mariana groups of islands. It grows only 80 per cent of its minimum food requirements. Its population is increasing a million a year. It must produce and export industrial products in large volume to live. It is short of natural resources and raw materials.

The Committee believes that the United States should now assist the recovery of Japan. Japan's industrial products are needed throughout the Far East, whose countries also need

Japan as a market for their potential exportable production—their tin, rubber, copra, wool, cotton, iron ore, bauxite, sugar, and rice. Japanese industry is operating at a very low level—less than 45 per cent of the 1930–1934 average. Shortage of needed raw materials is a major reason. However, the traditional will to work of the Japanese people themselves is still in evidence. Food production and coal production have been rising, although both are still far below minimum needs.

The reparations issue has not been settled. The Japanese do not yet know which plants and which equipment will be left to them, so, within industries thought to be subject to reparations, incentive to restore and reconstruct is suppressed. Plants which are needed in bringing about the recovery of Japan should be retained and only excess capacity removed. Otherwise the United States, which is now extending relief to Japan, would in reality be paying the reparations bill. The Committee states that the capacity that can be spared without affecting Japan's useful peacetime productivity is not great. It is most important that the present uncertainty be removed and the reparation issue be finally settled.

Japanese exports have been growing and reached $173,000,000 last year. Most of these exports, however, were made possible only by a special scheme of American assistance—particularly in cotton manufacture. A beginning has been made, nothing more. Total exports will have to increase to eight to nine times present levels to provide payment for the imported food and raw materials needed to sustain a reasonable standard of life in Japan. According to the Committee, it should be possible to accomplish this if tranquility is restored throughout the Far East, if present restrictions on Japanese trade and travel are lessened, and if help is given to import raw materials and get production going. An eventual shift in food and other imports from the dollar area to the sterling and Far Eastern areas, with compensation in Japanese industrial exports, is essential to any permanent Far Eastern recovery.

The Japanese merchant marine has been reduced by war losses to 20 per cent of its prewar size. Most of the larger ocean-going Japanese ships have been lost, with the bulk of the remaining fleet consisting of small coastal and fishing vessels. Payment to non-Japanese shipping of present-day inflated freights on essential imports is a large factor in Japan's foreign trade deficit. It is believed that Japan should be encouraged to increase its merchant shipping both by new building and by bareboat chartering of available vessels.

Principal among Japan's internal problems is the inflationary spiral resulting from the extreme scarcity of raw materials and consumer goods, the constant upward pressure of wages and other costs, and the heavy budgetary deficit. The internal cost of the occupation adds to this problem. Until this inflation problem can be solved by greater production, increased tax revenues, and more rigid control of government expenditures, the establishment of a stable foreign-exchange rate, and even of a stable internal economy, can hardly be achieved. Here again, the importation of greater amounts of raw materials and the resulting increased production will assist in a solution.

Drastic and continuing efforts by the Japanese themselves are necessary to balance the national budget. Self-help and self-sacrifice in clarifying and controlling internal price and wage relationships, in reducing national expenditures and increasing tax revenues, in expanding domestic production of food, coal, and products from other Japanese resources, are essential to proper use of any American assistance and of course to economic recovery itself.

In conclusion the Committee agrees with General Douglas MacArthur and the Department of the Army that industrial recovery of Japan on a peaceful basis is necessary to bring about a self-supporting economy; that this program has now properly become a primary objective of the occupation; and that the American Government in the national interest should support a reasonable recovery program.

The report states that in Korea the problem is complicated by the artificial division of the country into two zones of military occupation. The Koreans are eager for the independence to which our Government is committed.

Korean food production is improving and South Korea should eventually be able to supply its own food requirements if fertilizer requirements can be met. Other problems, however, are most acute. Lack of raw materials is greater even than in Japan. South Korea is dependent on North Korea for most of its electric power supply. The Korean railroads would stop if coal supplied by our occupation authorities in Japan were cut off. The industries which Japan developed during 40 years of Japanese control are operating at only about 20 per cent of capacity. South Korea is short of raw materials, and equally short of management and technical supervision formerly supplied by the Japanese. As in Japan, the United States has been supplying food, fertilizer, and petroleum products to keep the economy from collapse and to prevent widespread disease and unrest.

Here again the Committee believes that reasonable assistance should be given to finance importation of raw materials necessary to increased production of agricultural and industrial goods. An interim aid program, not limited solely to relief, should give a new Korean Government, when it is formed under the supervision of the United Nations, the needed help to establish the stable economic conditions so necessary to encouraging the development of free democratic government.

Finally, the Johnston Committee has examined the proposed recovery program prepared by the Department of the Army and supported by the State Department. The program would provide a total of $220,000,000 for a twelve-month period for raw materials and other recovery items for Japan, Korea, and the Ryukyu Islands. It is believed that such a recovery program is essential in order to reduce and eventually eliminate spending in these areas for relief.

As an occupying power, the Committee states, we have accepted a flag responsibility. The Committee believes the United States can discharge this responsibility better, and end it earlier, by concentrating on economic recovery and by gradually reducing relief. The Committee therefore recommends approval and execution by our Government of the suggested recovery program at the earliest possible date.

Monosodium Glutamate

MONOSODIUM glutamate, usually mixed with sodium chloride and other impurities, has for many years been one of the most prized savoring agents of the people of Asia. An article by Paul D. V. Manning, Ralph W. Shafer, and Frehn H. Catterson, International Minerals and Chemical Corporation, Chicago, Ill., and San Jose, Calif., discussing the manufacture of monosodium glutamate, appears in the July, 1948, issue of *Chemical Engineering Progress*. The authors state that because it is quite difficult to prepare in a very pure state and because its use has emphasized and brought out the hidden and often even unknown flavors in many foods, it has fallaciously been known as a flavoring agent. As a matter of fact, when quite pure and tasted by a mouth absolutely free from food particles, as when cleaned by a dentist, the product will be found to be without flavor, but with a somewhat salty sweet taste.

This type of phenomenon, the ability of the product to accentuate food flavors, is by no means new, since sodium chloride

(common salt) has to a more limited extent the power of flavor accentuation.

Monosodium glutamate can be made in two forms, as the monosodium salts of the two isomers of glutamic acid. Only the monosodium salt of the *l* glutamic acid has the flavor-accentuating capacity. The *l* form of glutamic acid is also the naturally occurring isomer. It can be produced by acid or enzymatic hydrolysis of most proteins.

Hydrolysis of proteins by an alkali produces a racemic mixture of glutamic acids. This is a mixture of both the *l* and the *d* forms in equal amounts. Glutamic acid can be synthesized, but again the racemized mixture results and the resolution of this into the separate forms is a complex and costly process, so far used only in the research laboratory.

Although the industry has been active in the United States for a number of years, it has a much longer history in Japan where, prior to the war, both wheat and soybeans were used as raw materials. In the United States there are at the present time three producers with two others expected soon to get into operation. Raw materials used include wheat gluten, corn gluten, and the effluent from the desugaring of Steffenizing of beet-sugar molasses.

Although glutamic acid is a constituent of all common proteins, the first major problem encountered by the industry is that of an adequate source of raw material. The richest commercial source is in wheat gluten which when pure contains approximately 35 per cent of glutamic acid. However, the amount of gluten in wheat itself is not high since the protein content of wheat varies from approximately 8.6 to 17.2 per cent. On a dry basis the gluten fraction varies from 4.7 to 14.7 per cent.

Steam-Electric Station

THE design and operational features of the Industrial Canal Steam-Electric Station of the New Orleans Public Service, Inc., were described by Allen H. Jensen, Mem. ASME, and John F. Vogt, Jr., New Orleans Public Service, Inc., New Orleans, La., at the 1948 ASME Spring Meeting.

The new plant is laid out to accommodate four turbogenerators. The general plant site is an area of approximately 30 acres. In addition, a tract of land measuring 700 ft × 650 ft has been leased from the Board of Commissioners of the Port of New Orleans. Outdoor electric facilities are provided for and include auxiliary transformers; 13-kv switchyard with outgoing local feeder circuits; a bank of 13/110-kv step-up transformers; control house for dispatching; and 110-kv switchyard connecting with Market St. Station, with existing 110-kv Florida Ave. Substation, and with 110-kv interconnections to the adjoining systems of the Louisiana Power & Light Company.

The station has been designed for initial use of gas and oil, and provision made to allow burning of pulverized coal. Docks along the canal will be utilized for mooring and unloading oil and coal barges, and coal-storage space is provided in the leased tract.

Water from the Industrial Canal is employed as a source of direct condensing cooling water for the station. The intake and discharge structures are designed to accommodate the requirements of a four-unit plant. Screen chambers with both revolving and stationary screens have been planned to provide for two turbine units to each screen chamber. Circulating-water pumps are located at the screen chamber, and intake and discharge of the cooling water from canal to screen chamber and from screen chamber back to canal is through concrete tunnels. Condensing water from pumps to condensers travels through steel conduits.

The initial step in providing new power capacity for New Orleans was the installation in 1947 of a unit plant of 37,500-kw capacity having throttle steam conditions of 1250 psi and 950 F, see Fig. 3. Enclosure is provided for the turbogenerator, with removable roof hatches through which turbine parts are handled by a gantry crane.

The boiler is of outdoor design with an enclosed firing aisle adjoining the main building. Boiler forced- and induced-draft fans are located outdoors adjacent to the boiler on concrete pedestals. This installation, see Fig. 4, is a unit boiler-turbine system employing a 1250-psi, 950-F, four-extraction point, cascading, regenerative cycle. A 400,000-lb per hr boiler supplies a turbogenerator rated 37,500 kw at 3.5 in. Hg. Feedwater is heated in three closed heaters and one deaerating heater, and delivered to the boiler at a final temperature of 390 F by any two of three half-duty boiler feed pumps. The second unit scheduled for operation during 1948 will be a duplicate of the first unit.

The boiler is a two-drum bent-tube boiler equipped with a pendant superheater; extended-surface tube economizer; regenerative-type air preheater; a single forced-draft fan; and two induced-draft fans. The boiler heating surface is only 32 per cent of the total of 16,000 sq ft (boiler and water walls) and in this installation all tubes of the boiler proper act as downcomers. The volume of the furnace is sized to give a heat release of 18,500 Btu per cu ft when burning coal, thus insuring a dry bottom. Although designed for pulverized-coal firing, the boiler is now equipped to burn only natural gas and fuel oil. Fuel is fired by six trifuel burners, employing ring-type gas burners and mechanically atomizing oil burners.

Since the superheater is made in two sections, an intermediate header is provided between the inlet and outlet headers. The low-temperature section consists of 68 sections of 6 loops each of 2-in-OD carbon-steel tubes, and the high-temperature section consists of 40 sections of 4 loops each of $2^1/_2$-in-OD

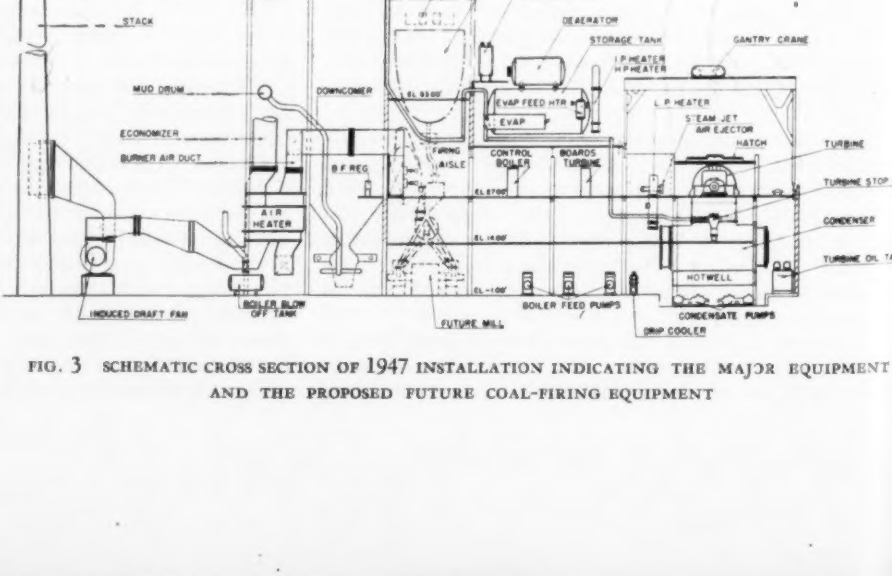

FIG. 3 SCHEMATIC CROSS SECTION OF 1947 INSTALLATION INDICATING THE MAJOR EQUIPMENT AND THE PROPOSED FUTURE COAL-FIRING EQUIPMENT

tubes. Three loops are of 4 to 6 per cent chrome steel and the loop nearest the furnace is 18-8 stainless steel. The steam temperature is controllable over 44 per cent of the boiler output—from 225,000 lb per hr to full rating. Superheat temperature control is effected by reducing the quality of the steam in the superheater inlet header. Boiler feedwater, circulated through a bundle of tubes located in each end of the inlet header, partially condenses entering steam so that heat added in the superheater will give the desired final temperature. A continuously recording controller regulates the final temperature by varying the flow of boiler feed through the tube bundles. To supply the turbine throttle conditions of 1250 psi and 950 F, the boiler must supply steam at 1350 psi and 955 F.

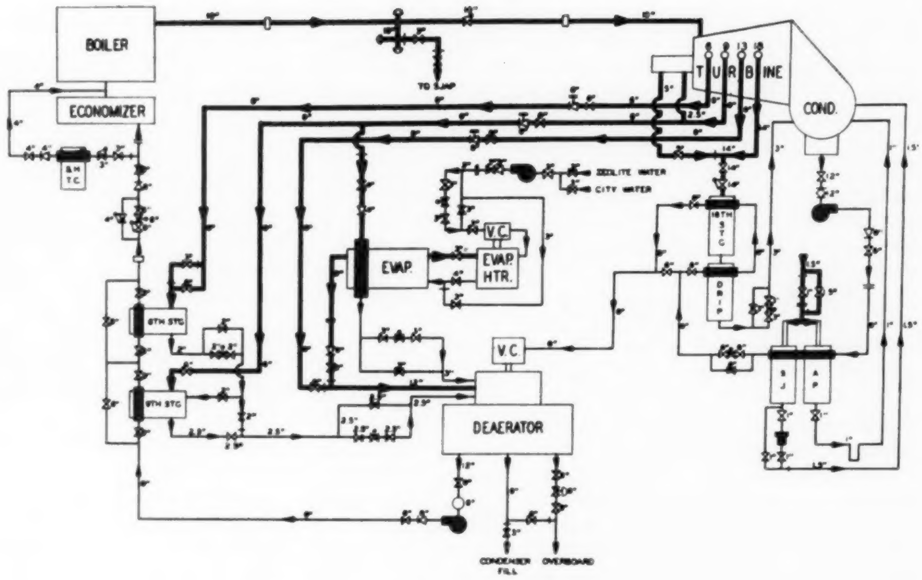

FIG. 4 FLOW DIAGRAM FOR UNIT NO. 1

The turbine is a 30,000-kw (nominal), 3600-rpm, 21-stage, tandem, compound machine. The high-pressure cylinder contains 18 stages, providing extraction steam at the sixth, ninth, thirteenth, and eighteenth stages, and the low-pressure cylinder is provided with three double-flow stages. Direct-connected to the turbine is a hydrogen-cooled, 13,800-volt generator rated at 35,000 kw (nominal) at 0.8 pf. Under tests conducted after installation, the turbogenerator produced 44,300 kw and 54,000 kva, operating at a back pressure of 2.44 in. Hg. Under service conditions the unit has been operating almost continuously between 40,000 and 43,000-kw output.

As shown by Fig. 4, condensate from a deaerating-type hot well is heated in the 18th-stage heater and its associated drip cooler and the 13th-stage deaerating heater. Taking suction from the deaerator the boiler feed pumps supply boiler feed to the boiler through the 9th and 6th-stage closed heaters. These pumps are rather unusual for this pressure application in that the casings are split horizontally and are made entirely of 18-8 stainless steel. Although these pumps are nominal half-duty pumps, they are sized to serve a boiler rating of 320,000 lb per hr on a single pump. The feedwater regulator is a hydraulically operated, single-element type, employing as a sensitive element, a flexibly connected mercury U-tube mounted on a ball-bearing pivot. The valve is a double port, turbine-type valve.

The boiler unit is guaranteed at 310,000 lb per hr for an over-all efficiency of 83.4 per cent when using natural-gas fuel. With oil as fuel the guaranteed efficiency is nearly 88 per cent.

The over-all estimated heat rate of the cycle at full load of 37,500 kw, and with a back pressure of 2.5 in. Hg, is 11,800 Btu per kwhr net output.

In summarizing the foregoing, the authors state that it is believed that the initial phases in the power-expansion program at New Orleans have been satisfactorily completed. A modern boiler-turbine unit has been installed which has proved to be highly efficient in operation. In addition, future growth at the Industrial Canal Station has been provided for in a manner that will allow considerable expansion of system capacity before maximum possible development at this site will have been attained.

Cold Rubber

A NEW production method may drastically alter the long-range outlook for synthetic rubber, according to an article in the *Industrial Bulletin* of Arthur D. Little, Inc., June, 1948. Basically, the change involves the use of new "speed-up" chemicals to permit the rubber's raw materials to combine at temperatures from 0 to 41 F, instead of at 122 F. Recent legislation has insured that synthetic rubber will continue to be produced and used in large volume; the new process may allow synthetic to compete with natural on the basis of quality.

Many rubber technologists think that tire-tread stocks made from the new synthetic are superior to natural rubber. Exhaustive tests have already proved that treads using the low-temperature product are 30 to 40 per cent better under the test conditions than any previous synthetic. Finished stock of the new rubber has exceptionally high wear and abrasion resistance without excessive tread cracking. These improvements seem to come from the fact that in the cold rubber most of the molecules are of a more favorable size and composition, while in the older synthetic a large share ignored the chemist's directions.

Important as the development may be in itself, from the long-range standpoint it signifies that improvement on the old GR-S general-purpose synthetic is possible, and hence might continue. On this basis, private industry will take greater interest in its industrial possibilities. Many factors in production of the new "cold" rubber itself are currently being further investigated. Two Government-owned plants operated by rubber companies are producing the new material; use in tire-tread stocks this year is expected, but not in large volume. A bottleneck in applying the method on a large scale is the scarcity of refrigeration equipment to attain and hold the low temperatures.

Although the new "Rubber Act of 1948" declares that eventual private control of the rubber industry is desirable, it continues government ownership until 1950, pending development of a policy toward transferring ownership. The Reconstruction Finance Corporation will be responsible for all operations and continued improvement of synthetic rubber. The new legislation requires the government to keep in operation or stand-by condition plants with an annual production capacity of 600,000 long tons of general-purpose rubber and 65,000 long tons of

special rubbers. Of this total, manufacturers must use at least 200,000 tons of the special synthetic. Actually, it is expected that production and consumption of all types of synthetic will be about 392,000 long tons in 1948; for the first quarter of 1948 production was at the rate of 430,000 tons a year. In 1947, before natural rubber was freely available, the United States used 563,000 tons of synthetic and 563,000 tons of natural rubber. Capacity for 100,000 tons of general-purpose rubber above the 600,000-ton minimum is owned by the Government; these plants can be privately purchased if the National Security Resources Board approves. The Act also authorizes negotiations to modify the rubber companies' wartime patent pool, thus opening the way for competitive research.

At present, synthetic rubber at 18.5 cents is about four cents a pound cheaper than the natural product. At this price, GR-S will be favored for tire treads, particularly if government stockpiling boosts the price of natural rubber. One form of cold rubber is reported to be exceptionally promising for tire carcasses, where previous synthetics have been at a disadvantage because of poor adhesiveness. Such factors as the volume of tire production and improved quality will affect the rate at which general-purpose synthetic supplants natural rubber. It now appears that GR-S in some modification may eventually replace natural rubber.

The special-purpose rubbers are already firmly established in their own fields. Butyl rubber, for instance, retains air and other gases much better than natural rubber, and is preferred for tire tubes and some balloon-type uses. Other rubbers are equally apt for special fabric- and wire-coating jobs where oil resistance is needed.

British Industries Fair

A REPORT on the British Industries Fair, held May 3 to 14, 1948, in England, was received recently from Dean W. R. Woolrich, Fellow ASME. Dean Woolrich, now senior scientific officer, American Embasssy, London, is sending ASME, by special request, reports of his observations abroad. He was formerly the dean of engineering, University of Texas, Austin, Texas.

According to Dean Woolrich, the BIF was three fairs all staged concurrently in exhibition pavilions of gigantic proportions. Even these extensive facilities were all utilized and one of the three had to supplement its indoor space by displaying fully one fourth of its exhibits in available out-of-doors courtyards.

The exhibit buildings utilized were Earls Court Ltd., and Olympia, Ltd., in London and Castle Bromwich Aerodrome in Birmingham. At each of the London centers approximately three hundred firms or associated groups exhibited their displays, most of which were directed toward inducing wholesale purchase by foreign or colonial buyers. However, a considerable number of displays booths were devoted to educational exhibits to demonstrate how certain public and government agencies were available to aid and stimulate industry both at home and abroad. More than twenty commonwealths, mostly colonial, displayed the products indigenous to their area. Their exhibits were concentrated for the most part at Earls Court.

At Castle Bromwich Aerodrome this general pattern of the London exhibits was repeated. Approximately one thousand exhibitors had space. By previous announcement the division at Castle Bromwich Aerodrome, Birmingham, was called the engineering and hardware section, but a critical analysis of the displays at Birmingham and at London revealed there was no monopoly of the engineering equipment at Birmingham nor was there any shortage of general and commercial displays there.

A feature of the Birmingham section was the comprehensive displays featured by industrial English cities, especially of the Midland area, in which they exhibited a wide variety of products and equipment produced in their respective industrialized environs.

Dean Woolrich indicates that of interest to all scientific groups was the fact that a large number of these exhibits and displays were more than a display of available goods, instruments, or equipment. In all three exhibit pavilions there were demonstrations of new scientific and engineering processes, instruments, and machines upon which Great Britain intended to take a very active position at the head of the industrial and scientific equipment procession. The imprint of the efforts and results of the Department of Scientific and Industrial Research, familiarly called the DSIR, was very noticeable in all phases of industrial advancement at both London and Birmingham.

In the London exhibits, artistic as well as practical goods in the fields of leather products, chinaware, furniture, and high-grade jewelry were on display. The value of the diamond display alone was reputed to exceed one million pounds.

In scientific goods, especially electronics, radio, television, and microscopical and optical instruments, the displays were impressive both in variety and in scientific advancement.

According to Dean Woolrich, the foreign observer was forcefully impressed with the enthusiasm and optimism with which British manufacturers had responded to the call to prepare a high-quality product for export, when in a large proportion of the cases these same manufacturers realized that under the austerity plan of the Government only a small amount of all such products or equipment could legally be sold to the home market. They had been responsive to the appeal to make their bid for export trade with the full knowledge that there was practically no backlog of home orders that could carry the load of new tooling and research essential to the maintaining of leadership in any modern manufacturing field.

At Castle Bromwich this spirit of optimism was even more evident than at Olympia or Earls Court. Farm power machines from "Calf dosers" to heavy tractors, farm equipment from hard tools to large grass driers, and earth excavation equipment from spades to a wide variety of very heavy power shovels were on display in the outer courtyards.

Within the pavilion at Birmingham the machine-tool display alone would place Great Britain in a highly competitive position with the best in North America for peacetime precision equipment. But similar quality exhibits were available in electrical machines, ferrous and nonferrous metals, aluminum and steel dimension shapes for construction, and steam and Diesel-power units, testing machines, and gas turbines.

Probably the gas turbine built for truck and other automotive applications was Castle Bromwich's greatest attraction for the public at large. Although to mechanical engineers it was as a unit that must be classed as more interesting than economical, it had thousands of admirers. On the other hand, few noted that under the same exhibition roof Metropolitan-Vickers Electrical Co. Ltd., of Manchester, were exhibiting the model and heat diagrams of a 1500-hp gas turbine that they were building for their own power plant as a stand-by unit, and adjacent to this exhibit was a second heat-flow diagram of a 15,000-hp gas turbine they were constructing for the Northwest Electric Power Board of England, to be installed at Manchester.

For some years to come, writes Dean Woolrich, the Diesel and the Otto Cycle internal-combustion engines of the world will have little to fear from the competition of the small jet gas turbine in spite of its attractiveness to the lay public, but the

large-capacity units under construction at Metropolitan-Vickers that were largely unnoticed by most laymen will, like their prototypes in the process of production within the United States and Switzerland, give steam, Diesel, and water power a more rigorous race for position within the next decade.

The material and equipment displays at the British Industries Fair were in themselves very impressive as to what a nation can accomplish in orienting itself from wartime to peacetime production, especially when such a nation is economically pressed in a battle for its very existence. But what was exhibited materially was only a minor part of the British Industries Fair—as commendable as these were.

Behind, in front, and permeating through all of this was a spirit of togetherness of trades people, buyers, industries, towns, colonies, commonwealths, government, and the royal household itself.

Materials Handling

INADEQUATE materials-handling techniques are resulting in high production costs and production delays for hundreds of small and medium-sized businesses, according to S. W. Corbin of General Electric's Resale Industries Division.

Speaking with other G-E engineers and materials-handling experts at a New York City press preview for that company's new "More Power to America" program on "Materials Handling in Receiving, Shipping, and Warehousing," Mr. Corbin asserted that these companies often don't even know that they have a materials-handling problem. He said that they just don't realize how modern materials handling can help them cut costs, increase production, reduce inventories, and relieve man-power shortages.

Speaking on "The Problems of Materials Handling," J. R. Kilander, materials-handling expert of G-E's Apparatus Department Manufacturing Divisions, called for a major revision in present accounting procedure to reveal the true costs of materials handling. When such systems are available, making it obvious just what it does cost to move a ton of steel from boxcar to warehouse to factory, top management will begin to take more of an interest in materials handling, he said. Such a system would reveal the spots where work should be done first.

Mr. Kilander also recommended the delegation of competent engineers, on a full-time basis, to materials-handling problems with full authority to put their findings into action. Increased standardization and simplification of equipment and methods were also suggested as a solution to many handling problems.

He predicted the future free flow of shipping pallets between companies and areas in place of present restrictive regulations, and said that use of short-wave radio or tractor trains and trucks within large plants might do much to assure full utilization of equipment.

The new materials-handling program, thirteenth in the More Power to America series, typifies exactly the MPA philosophy of increased benefits through electrification and modernization, F. W. McChesney said at the meeting. He is a mem berof G-E's main MPA committee.

He stated that there is still far too much use being made of the old "Hernia Method" of moving materials from one place to another. That may have been effective thirty or forty years ago but, today, with the cost of labor what it is, and the necessity of meeting tremendous production schedules, it isn't only out of date, it is bankruptcy, in many cases, not to change.

Notwithstanding the fact that electric motors furnish about 86 per cent of today's industrial horsepower, American industry is less than 50 per cent electrified in terms of jobs that electricity can do most efficiently and economically, Mr. McChesney pointed out.

The entire new materials-handling program features a sound Kodacolor motion picture and a manual containing extensive descriptive data. The picture illustrates all types of materials-handling equipment and shows installations in which each is best used. The manual contains data, said to be available nowhere else, on engineering problems, power distribution, and the selection of equipment connected with materials handling. It is available from G-E at one dollar per copy.

Thermoelectric Generators

THE conversion of heat to electric energy by the phenomena of thermoelectricity has been considered for many years as a desirable means of obtaining direct-current power which does not require moving parts and as much maintenance as presently exists, especially in the present types of generators that are driven by gasoline engines. An article in *Electrical Engineering*, July, 1948, by Grenville B. Ellis, chief, Battery Branch, Squier Signal Laboratory, Signal Corps Engineering Laboratories, Fort Monmouth, N. J., considers the thermoelectric effect in the conversion of heat to electric energy.

According to Mr. Ellis, the recent war brought about renewed interest in thermoelectric generators as they did offer certain characteristics for portable power supplies that fitted into the military picture. These characteristics were extreme portability, quietness of operation, a pure source of direct-current power, low maintenance, as well as certain practical considerations such as a source of heat for personal comfort and preparation of food. Experimental work was conducted by the Army to the point where some types of thermoelectric generators were used. The elements of these units were chromel-constantan couples and were heated by wood, charcoal, and, in some instances, gasoline, as required. The use of these, as crude as they seemed, did indicate that a definite place for such generators existed provided that their over-all efficiency could be brought into line with portable engine-driven generators. It was not believed practical to consider such generators for large power but to examine their use in the 200 to 300-watts range where engine and generator maintenance in present units always has presented a major problem. The results of research and resultant generator design may change this thinking radically and very well could result in consideration of higher power units.

The present types of generators have a ratio of weight to power of about 2.1 lb per watt, including gasoline fuel for eight hours' operation. Generators were designed up to 40 watts output, having this ratio. The maximum potential provided in any of these generators was on the order of 12 volts. It is understood that the Eaton Manufacturing Company, Cleveland, Ohio, has done some work on a 90-volt unit believed to be the only commercial unit developed in recent years. The efficiencies of these units ranged in the order of 0.2 of one per cent based on an over-all efficiency from fuel to direct-current power output and was not truly indicative of the possible efficiency as a considerable improvement could have been obtained if more practical use could have been made of the heat available from the source.

An analysis of these generators indicates three general problems that must be considered in any program which is intended to improve the over-all efficiency to a point where it can become a competitive power supply to existing conversion units. These involve the following: (1) Thermocouple for maximum power efficiency; (2) optimum heat-transfer system; and (3) proper heat source.

These three present difficult and complex design problems, especially when economy, weight, size, noise, and efficiency are being considered. It is impossible to divorce one from the other as they are interdependent.

The development of an efficient thermocouple is probably the most important first consideration because there must be a certain minimum acceptable efficiency in the couple and this minimum will determine whether it is practical to proceed with the balance of the generator. It is understood readily that this efficiency should be as high as practical and higher than any obtained to date on any observed couple combinations.

Research has been initiated by the Signal Corps to determine if such a couple can be formulated and what its characteristics should be.

The study of the over-all concepts of thermocouple and generator design, both from the theoretical and practical point of view, has indicated certain parameters which are believed to indicate some physical and electrical characteristics which must be satisfied before a thermocouple could be considered seriously as an efficient power source. Some of the most important are the following:

1 Maximum hot-junction temperature of approximately 1000 F.
2 Potential characteristic of 600 microvolts per deg C.
3 The structure should be mechanically strong.
4 Low internal resistance.
5 Should resist oxidation over prolonged periods.

Observations of literature and experimental data show that such a couple has not been developed as yet. The examination of the characteristics of metals indicates that a combination of metals would not produce such a couple. The best approach may be in the field of semiconductors, incorporating trace elements to adjust properly the thermal and electrical conductivity, and structural characteristics.

Such a generator properly worked out, with an efficiency in excess of eight per cent, would revolutionize conversion units in the small power field and find a definite place for itself in the commercial and military fields of application.

Transistor

AN amazingly simple device, capable of performing efficiently nearly all the functions of an ordinary vacuum tube, was demonstrated recently at Bell Telephone Laboratories, New York, N. Y., where it was invented.

Known as the transistor, the device works on an entirely new physical principle discovered by the Laboratories in the course of fundamental research into the electrical properties of solids. Although the device is still in the laboratory stage, Bell scientists and engineers expect it may have far-reaching significance in electronics and electrical communication.

The whole apparatus is housed in a tiny cylinder less than one inch long. It will serve as an amplifier or an oscillator, yet it bears almost no resemblance to the vacuum tube now used to do these basic jobs. It has no vacuum, no glass envelope, no grid, no plate, no cathode, and therefore no warm-up delay.

Two hair-thin wires touching a pinhead of a solid semiconductive material soldered to a metal base, are the principal parts of the transistor. These are enclosed in a simple metal cylinder not much larger than a shoelace tip. More than a hundred of them can easily be held in the palm of the hand.

Since the device is still in the experimental stage, no data on cost are available. Its essential simplicity, however, indicates the possibility of widespread use, with resultant mass-production economies. When fully developed, the transistor is also expected to find new applications in electronics where vacuum tubes have not proved suitable.

FIG. 5 TRANSISTOR

Tests have shown that the transistor will amplify at least 100 times (20 decibels). Some test models have been operated as amplifiers at frequencies up to ten million cycles per second. Because of the basically simple structure of the new units, stability and long life are expected.

In the transitor, two point contacts of the "cat's whisker" or detector type, familiar to radio amateurs, are made to the semiconductor only 0.002 in. apart. Input power delivered to one of these contacts is amplified at least 100-fold and transmitted to the other terminal where it is delivered to an output circuit. The transistor is energized by voltage supplies, such as batteries, which apply bias voltages to the two points. The power actually consumed in the transistor is less than a tenth that used by an ordinary flashlight bulb.

The amplification process can be understood in terms of the discovery made by Dr. John Bardeen and Dr. Walter H. Brattain, who did the principal work on the transistor, that the input point is surrounded by an "area of interaction." Within this area the electronic structure of the semiconductor is modified by the input current. Now, if the output point is placed in this area, the output current can be controlled by the input current. This control of output current by input current is the basic mechanism of amplification.

Molybdenum

THE varied applications of molybdenum as an alloying element are described in a new book entitled "Molybdenum: Steels, Irons, Alloys," by R. S. Archer, J. Z. Briggs, and C. M. Loeb, Jr. A wide range of materials from wrought to cast steels and from cast iron to nonferrous alloys is covered. The major emphasis has been placed on the presentation of the fundamentals that must guide all engineers, designers, and metallurgists in their selection of the most suitable materials for a given application.

An attempt has been made to show the fields of similarity and dissimilarity of the various materials and to indicate some of the factors that may affect the choice of the most economical material for a specific part.

The scope of the book is illustrated by the following main section headings: Technical Effects of Molybdenum, Fundamental Effects of Heat-Treatment on Microstructure, Addition of Molybdenum, Wrought Alloy Engineering Steels, Wrought Corrosion-Resistant Steels, Wrought Steels for Elevated Tem-

perature Service, Tool Steels, Steel Castings, Cast Iron, Special Purpose and Nonferrous Alloys.

Considerable recent information is included, not only on the more prominent developments, such as the gas-turbine steels and alloys, but also on the work that has served to clarify the factors affecting the service life of the lower-alloy steels. The references to current literature are adequate to facilitate further reading by anyone who desires more detailed data.

A valuable addition is said to be the compilation of much rather obscure, hard-to-find information on some of the specialty applications, such as: exhaust valves, elevated-temperature springs, ferritic gas-turbine steels, high-permeability alloys, contact materials, grid wires, and prosthetic alloys. The appendixes include data on standard compositions of American, British, and French engineering steels, working stresses from the ASME Boiler Code, conversion tables, and the physical properties of metallic molybdenum.

The book contains 391 pages, 188 figures, 91 tables, plus appendixes, and is available to all metallurgists and others closely connected with the metallurgical industries, free of charge, from Climax Molybdenum Company, 500 Fifth Ave., New York 18, N. Y.

Table of Coefficients

PUBLICATION of a 20-page "Table of Coefficients for Obtaining the First Derivative Without Differences" has been announced by the National Bureau of Standards and made available as NBS Applied Mathematics Series 2.

This table, permitting the calculation of the derivative at a point within a tabular interval by a single machine operation, will be of value in many fields of applied mathematical computation where it is desirable to find the derivative of a function that is tabulated at uniform intervals. It will be particularly useful in the location of maxima and minima, in thermodynamic calculations where many functions are found as derivatives of other known functions, and in ballistic computations for slopes of trajectories.

Exact values of the polynominal coefficients $C_i(n)_{(p)}$ are given for p ranging from $-[(n-1)/2]$ to $[n/2]$. For $n = 4, 5,$ and 6, the coefficients are tabulated at intervals of 0.01; for $n = 7$, they are tabulated at intervals of 0.1. No table is necessary for $n = 3$ as the coefficients may be obtained by means of a simple formula.

Applied Mathematics Series 2, Table of Coefficients for Obtaining the First Derivative Without Differences, may be obtained only from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., at 15 cents per copy.

Industry Develops Engineers

(*Continued from page 749*)

both of the engineer and of the profession. It is an effective way of increasing the store of engineering knowledge and of providing for further increase of that knowledge. Furthermore, the author of a paper undergoes a rigorous self-training course. The preparation of a technical paper involves not only the presentation of the knowledge which the engineer possesses by virtue of his experience but also a co-ordination of that knowledge with that already available on the same subject. It requires a thorough study of the material previously published on the same and allied subjects, a recognition of the limitations of that knowledge, and a logical organization of the material in the engineer's mind for most effective presentation. The unique and intensive mental activity engaged in by the engineer during the process of preparation of a technical paper is development along engineering lines in its most effective form. For this reason, it should play a major role in the company's plan of engineering development at the advanced level.

The key to promoting interest for advanced training in the engineer along the lines mentioned in this paper is definite encouragement by the company of these activities. Under proper stimulus, an engineer is potentially capable of almost unlimited effectiveness to the company and is a valuable asset on the company's books. He should be regarded and treated as such.

ACKNOWLEDGMENT

The author wishes to express his appreciation to Mr. E. C. Koerper for his assistance in the preparation of this paper, and to the companies in the Milwaukee area which so generously provided the information requested in the questionnaire and in later discussions of the subject with them.

Ten Months of the Taft-Hartley Act

(*Continued from page 754*)

pension funds has not yet been settled conclusively. In any event, there must sooner or later be some order brought out of the present chaos.

The welfare-fund problem raises whole new social issues which must be explored carefully. What are the relative rights of single employees and those with large families? How widespread a coverage should welfare funds encompass? The recent coal strike was caused, among other reasons, by attempts to provide pensions for nonemployees. In any hospitalization or surgical benefits plan there is always the question of wives or husbands, children, and other dependents. If health and accident insurance should ever be extended to nonemployees there would be very little basis for actuarial determination or control.

The Joint Committee on Labor-Management Relations is studying this problem and will be expected to make recommendations to Congress. Undoubtedly, some legislation will result which should, at the very least, delimit the problem.

The final question is easy to answer; it is: "There have been recently some strikes and numerous threats of strikes aimed at forcing employers to agree to contracts either violating the law or evading it. Should such strikes or threats of strikes be made unlawful?" The answer is an emphatic "yes."

CONCLUSION

In conclusion it is predicted that no changes will be made in the Taft-Hartley Act this year. On the whole, it is working well and solving long-felt needs. Employers and employees have been slow to utilize their rights under the Act. There is not enough experience as yet to indicate whether eventually they will do so but if not, it may be necessary to have the initiative provided elsewhere. Restrictions against a number of union practices, such as feather-bedding, secondary boycotts, mass picketing, blacklisting, and others are being tested before the board and the courts. The outcome of these tests will have a far-reaching influence on labor relations.

The Taft-Hartley Act is an effort to contribute a constructive approach to union-management relationships. It emphasizes the common responsibility of both groups to the over-all or comprehensive interests of the whole nation. Its principles extend back to Teddy Roosevelt's famous remark during the 1902 coal strike, "You mineworkers think you own the men; you labor leaders think you own the mines. You are both wrong."

ASME TECHNICAL DIGEST

Substance in Brief of Papers Presented at ASME Meetings

Design and Standardization of Splines

Hobs for Spline Shafts, by Anthony F. Zamis, Illinois Tool Works, Chicago, Ill. 1948 ASME Semi-Annual Meeting paper No. **48—SA-19** (mimeographed).

Preference for the hobbing process in the production of spline shafts is due largely to the character of the process with respect to the spacing and the tooth form of the spline keys. Accurate spacing is essential to enable each spline key to carry its share of the load. In the hobbing process, where a single-thread hob is employed, the spacing of the keys is not dependent upon any indexing arrangement, either manually operated or automatic. It is controlled, instead, by the motions of the hobbing machine which is so designed as to minimize the effect of machine errors on the spacing of the hobbed part.

The actual tooth-to-tooth spacing error of hobbed gear teeth or spline keys is usually less than ordinary means can detect. The common point-to-point method of checking this spacing is affected by any roughness of the cut surface, which roughness usually far exceeds the actual spacing error in magnitude.

With respect to tooth form, the advantage of hobbing over most other means of producing splines is the freedom with which the hob may be positioned in relation to the work. Other than the depth of cut which controls the tooth thickness, the operator's only responsibility for the setting position of a properly mounted hob is to make certain that the work lies within the ends of the hob in order that the generation of the keys will be complete. If, for any reason, the key is not finish-generated, this failure can be detected by visual inspection as the normal pattern of the feed marks will be interrupted.

Hob design for parallel key splines is a compromise between the desire for a spline key straight to its tip and a small fillet in the root. Furthermore, the hob tooth profile is curved and its ability to produce the correct spline shape depends considerably on the cutting depth.

None of these difficulties are present in the design of involute-spline hobs, and the editors of the new American Standard Involute Spline have evolved a spline system whose adaptation to hobbing has been given every consideration. Longer hob life, reduced number of hobs required to cut all standard splines, and interchangeability of hobs are some of the benefits of this standard.

Involute-Spline Experience, by Charles H. Stanard, Buick Motor Division, General Motors Corporation, Flint, Mich. 1948 ASME Semi-Annual Meeting paper No. **48—SA-20** (mimeographed).

This paper is primarily concerned with the manufacturing and functioning of splines in the automotive industry. It is desired to show the advantages of the involute splines, based upon observation of mass production which enables the establishment of the pattern of behavior both in response to machining and in functioning.

The early experience has to do with square shafts, jawed clutches, keys, and straight-sided splines, and the gradual change to involute-formed fasteners or driving means. This period disclosed the effects of errors and how the errors related to methods of machining and the movement of metal during heat-treatment.

The early adoption of the involute form and the production of multiple-keyed shafts and fittings on gear machining showed the sharp contrast in accuracy obtained and the ability to modify size and shape to compensate for hardening growth with the continued use of the involute splines. It was observed to be adaptable for every purpose, easily machined, functionally strong and satisfactory. A broad standard is available.

Gas-Turbine Power

Performance of Commercial Gas Turbines, by Paul R. Sidler, Mem. ASME, Brown Boveri Corporation, New York, N. Y. 1948 ASME Spring Meeting paper No. **48—S-7** (mimeographed).

The design and operating results obtained from several commercial gas-turbine sets during the last two years, giving details on starting characteristics, efficiency, etc., are discussed.

A 10,000-kw stand-by and peak-load unit for the Filaret Power Station in Rumania consists of two pressure stages, an intercooler between the two compressors, two combustion chambers (reheat), but without an air preheater.

The generator, designed for 12,500 kva, 80 per cent power factor, 5300 volts, 50 cycles, is directly coupled to the low-pressure turbine compressor, operating at 3000 rpm. This arrangement results in low cost but also in relatively low efficiency, as is entirely fitting for stand-by power plants.

Tests with this unit showed good overload capacity, reaching a maximum of 12,000 kw with an air-inlet temperature

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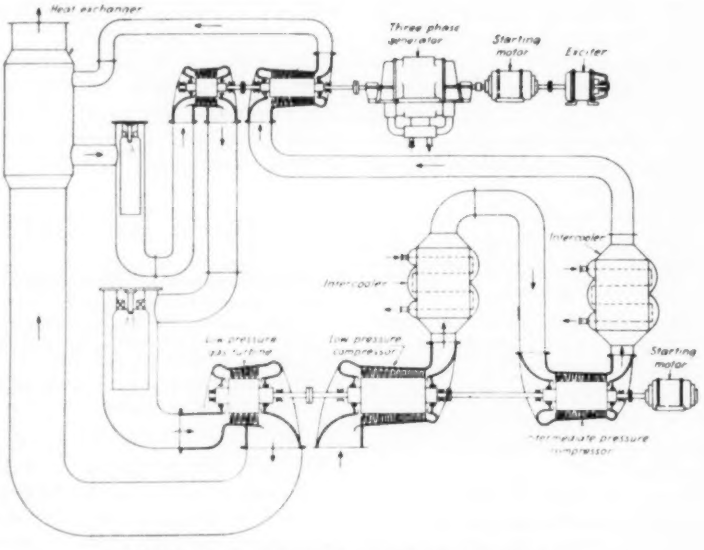


12,000-KW GAS-TURBINE SET FOR LIMA, PERU

of 68 F and a maximum continuous gas-inlet temperature somewhat below 1100 F.

Another set of the same capacity, 12,000 kw, but for base-load operation is now being set up in Lima, Peru. It is very similar to that of the Filaret unit but carries the subdivision of the air compressors one step further, again with intercoolers between the stages.

The generator is coupled to the high-pressure set which allows for quicker response of the air flow to changing load, since the low-pressure set which takes the air from the atmosphere can vary its speed. There is also a heat exchanger, using the exhaust gas from the low-pressure turbine to preheat the air going into the high-pressure combustion chamber. All these arrangements make for high efficiency at all loads, as is proper for a base-load machine. The guaranteed over-all efficiency for this unit was 28 per cent (12,250 Btu per kwhr) and tests have confirmed it with a comfortable safety margin.

Another gas-turbine set, built with single shaft and directly coupled generator, running at 3600 rpm, is a stand-by set of 4000 kw, for Chimbote, Peru.

Other gas-turbine sets practically completed and ready for tests are two units, each of 1650/2000 kw for a cement plant in Venezuela, and two sets, each with a normal rating of 4000 kw, for an oil plant in Southern Iran, using natural gas as fuel. These natural-gas units will have no heat exchanger. Starting will be accomplished by a single-stage impulse turbine. The natural gas is available at the plant with a pressure of about 400 psig as it comes from the well. The impulse turbine reduces this pressure to about 60 psig as it is required in the combustion chamber.

Among the more recent gas-turbine sets ordered are a 13,000-kw and a 27,000-kw unit for installation in the Beznau Power Station in Switzerland, one of the major connecting points of a large hydroelectric system.

The present status of high-temperature alloys for gas-turbine work is also discussed.

Construction of Gas Turbine for Locomotive Power Plant, by William B. Tucker, Mem. ASME, Allis-Chalmers Manufacturing Company, Milwaukee, Wis. 1948 Semi-Annual Meeting paper No. **48—SA-54** (mimeographed).

A description of the coal-burning gas-turbine locomotive being manufactured by the Allis-Chalmers Manufacturing Company for the Locomotive Development Committee of Bituminous Coal Research Inc., is given.

This gas-turbine unit operates on the simple open cycle with regenerator and drives a direct-current generator through gears. Electrical transmission of power to the driving axles allows the use of a well-established transmission system for this service.

The gas-turbine unit consists essentially of the following principal components: axial-flow-type compressor; reaction-type turbine; direct-current two-shaft generator; reduction gear, consisting of a pinion between two low-speed gears which drive main generator shafts; straight tube-type regenerator; and combustion and fly-ash separator, to be furnished by user.

The prime-mover element is a six-stage reaction turbine designed to deliver 12,243 hp to the turbine-compressor coupling at a speed of 5700 rpm when the inlet-gas temperature is 1300 F and compressor air-inlet conditions are 14.7 psia and 70 F.

The compressor is of the axial-flow type and is placed between the turbine and main reduction gear. This arrangement allows sufficient space for a regenerator to be placed in the cycle in a position above the turbine and compressor. This type and size of compressor has demonstrated, by many tests, to be capable of operation with efficiencies exceeding 85 per cent.

A flyball-type speed-control governor, driven from the main reduction gear, is used.

In order for the gas turbine to be available for quick starting after shutdown, a turning gear, located in the bearing housing between the compressor and the reduction gear, will maintain proper thermal equilibrium by periodically turning the rotating elements.

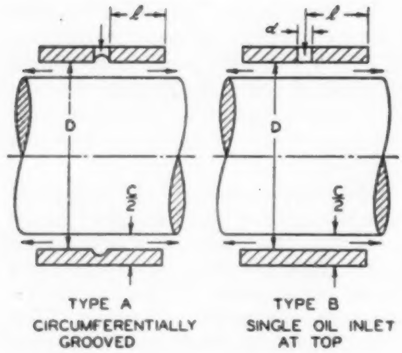
Lubrication

Oil Flow and Temperature Relations in Lightly Loaded Journal Bearings, by John Boyd, Westinghouse Research Laboratories, East Pittsburgh, Pa., and B. P. Robertson, Jun. ASME, Humble Oil & Refinery Company, Houston, Texas. 1947 ASME Annual Meeting paper No. **47—A-62** (in type; published in Trans. ASME, April, 1948, pp. 257–262).

The trend toward higher speeds for certain types of apparatus and the decrease in weight of the moving parts which usually accompanies such a change has resulted in the application of an increasingly large number of bearings which operate at relatively high speeds and comparatively light loads. Many of these applications use sleeve-type bearings which are supplied with force-feed lubrication.

Since shaft-rigidity requirements and practical considerations frequently dictate bearing size, the design of bearings for such applications is principally concerned with determining oil flow and running temperature rather than choosing proportions which will give maximum load-carrying capacity.

A fortunate consequence of light loading and high speed is that they permit the journal to run with negligible eccentricity. Thus for many practical purposes, the journal and the bearing may be considered as operating concentrically, a condition which greatly simplifies flow and loss calculations.



TEST BEARINGS

An important factor in determining the oil flow through a bearing is the type and distribution of the oil holes and oil grooves. The number of possible groove arrangements is of course infinite and much has been written on some of the various types.

In order to obtain data for designing bearings for such service, tests were carried out on the following two common types of journal bearings:

Type A—360-deg plain bearing with circumferential groove at mid-length.

Type B—360-deg plain bearing with a single oil-supply hole on top at mid-length.

The results of the tests have been compared with the theoretical values obtained for bearings of the foregoing types. The comparison indicates the extent to which the assumption of concentricity is applicable.

Metal Cutting

An Evaluation of Cylindrical Grinding Performance, by R. E. McKee, University of Michigan, Ann Arbor, Mich., R. S. Moore, Quaker Chemical Products Corporation, Conshohocken, Pa., and O. W. Boston, Fellow ASME, University of Michigan, Ann Arbor, Mich., 1948 ASME Semi-Annual Meeting paper No. **48—SA-9** (in type; to be published in Trans. ASME).

This paper, the third in a series on cylindrical grinding, presents some of the results of an investigation of the grinding process with particular reference to the influence of certain variables, such as wheel grain, grade, and velocity, table-traverse feed, depth of cut, and type of material.

Testing conditions, specifications of materials, effects of variance in grain size and grade of grinding wheels, and effect of variation in table feed and/or depth of cut are discussed.

It is indicated that a change in the peripheral velocity of a grinding wheel will affect its relative performance in terms of (1) volume ratio (metal removal per unit wheel wear); (2) unit net horsepower; and (3) surface finish. The data submitted in this paper support the use of 6500 sfpm as the proper peripheral velocity for a grinding wheel used in external cylindrical grinding.

With a set of conditions of 0.001 in. depth of cut and 0.081 ipr table feed, the unit net-horsepower requirement may be reduced appreciably by a decrease in grain size, but slightly increased with the use of harder grades for a given grain size.

A grinding rating of at least 0.154 might indicate favorable conditions, such as a volume ratio of 50, a unit net horsepower of 13, and a surface finish of 25 microinches.

An increase in table feed and/or depth of cut will reduce the volume ratio, increase the net power requirement, and give a poorer surface finish as applied to the grinding of steel.

An increase in table feed and/or depth of cut may increase the volume ratio, decrease the unit net power requirement, and give a poorer surface finish in the grinding of the cast irons.

Cast iron may be ground satisfactorily with aluminum-oxide grinding wheels, and a volume ratio up to 192 times as much metal removal as wheel wear has been recorded in this operation.

Applied Mechanics

Polygonal Approximation Method in the Hodograph Plane, by H. Poritsky, Mem. ASME, General Electric Company, Schenectady, N. Y. 1948 ASME Applied Mechanics Division Meeting paper No. **48—APM-23** (mimeographed; to be published in the *Journal of Applied Mechanics*).

This paper extends the discussion of the approximate method of integrating the equations of compressible fluid flow in the hodograph plane first presented by the author before the Sixth International Congress of Applied Mechanics, Paris, September, 1946. As an introduction to the polygonal approximation method, fundamental flow equations are discussed.

ASME Transactions for August, 1948

THE August, 1948, issue of the Transactions of the ASME contains:

I—Introductory Comments to a Series of Contributions on Gas Properties, by F. G. Keyes (Paper No. 47—A-161)

II—Molecular Constants From Spectroscopic Data, by G. Herzberg (Paper No. 47—A-162)

III—Heats of Formation and Chemical Thermodynamic Properties, by F. D. Rossini (Paper No. 47—A-163)

IV—Vapor Pressure, Specific Volume, p-v-T Data for H_2, N_2, O_2, CO, CO_2, Air, He, A, Hg, by Serge Gratch (Paper No. 47—A-164)

V—Vapor Pressure, Specific Volumes, and p-v-T Data for H_2O, NH_3, CH_4, C_2H_4, With Comments on Mixtures, by F. G. Keyes (Paper No. 47—A-165)

VI—Dielectric-Constant and Refractivity Data, by J. G. Miller (Paper No. 47—A-166)

VII—A Summary of Experimental Determinations of Joule-Thomson Effects in Gases, by H. L. Johnston and David White (Paper No. 47—A-167)

VIII—Brief Review of Available Data on the Dynamic Viscosity and Thermal Conductivity for Twelve Gases, by G. A. Hawkins (Paper No. 47—A-168)

Industry's Requirements for Data on Gas Properties, by N. A. Hall (Paper No. 47—A-169)

Facilities for, and Work Under Way in Gas-Properties Research, by R. V. Kleinschmidt (Paper No. 47—A-170)

Generalized Thermodynamics of High-Temperature Combustion, by H. C. Hottel, G. C. Williams, and C. N. Satterfield (Paper No. 47—A-21)

The Control of Structural Temperatures in Jet-Propelled Aircraft, by G. F. Anisman and M. W. Blackstone

Temperature-Reduction Problems in Sugar-Beet Storage, by R. D. Barmington

Condensation of Refrigerant Vapors—Apparatus and Film Coefficients for Freon-12, by R. E. White (Paper No. 47—A-91)

Prediction of Pressure Drop During Forced-Circulation Boiling of Water, by R. C. Martinelli and D. B. Nelson (Paper No. 47—A-113)

Analysis of Tests on Positive-Displacement Meters for Liquid Hydrocarbons, by E. E. Ambrosius (Paper No. 47—A-171)

Developments in Kraft-Process Recovery-Unit Design and Performance, by R. K. Allen (Paper No. 48—S-2)

Utilizing Bagasse as Fuel, by F. X. Gilg (Paper No. 48—S-3)

Experimental Combustion of Pulverized Coal at Atmospheric and Elevated Pressures, by H. R. Hazard and F. D. Buckley (Paper No. 47—A-117)

Instrument-Gear Standards and Design, by G. W. Kuntny

The Removal of Aldehydes From Diesel Exhaust Gas, by R. F. Davis and M. A. Elliott (Paper No. 47—A-108)

COMMENTS ON PAPERS

Including Letters From Readers on Miscellaneous Subjects

Locomotive Gas-Turbine Power Plant

Comment by J. T. Rettaliata[1]

The author has presented an interesting description of a gas-turbine power plant possessing many attractive features of design.[2] Undoubtedly, the unit described, employing to a large degree the highly desirable straight-through type of flow, approaches the ultimate in design simplicity. The latter achievement, however, is at the sacrifice of incorporating a regenerator which is believed by the writer to be worth while in many applications, including locomotives. Also, the use of a regenerator, in addition to resulting in a higher thermal efficiency, would permit operating nearer the optimum point of the cycle with a temperature of 1400 F and a pressure ratio of 6.

It is noted that it is planned to employ heavy fuels such as bunker C oil. The use of a liquid fuel greatly facilitates the handling and combustion problems, and is encouraged by the frequently recurring interruptions in the production of coal. On the other hand, with the expected thermal efficiency of 17 per cent at the turbine shaft, it would appear that compared with other types of locomotives the fuel costs may be excessive, and also some of the claimed weight and space advantages may be offset by increased fuel requirements. With a transmission efficiency of 83 per cent, the fuel cost would be about 0.58 cent per rail hp-hr assuming the bunker C fuel costs 5 cents per gal, a representative figure in the East. In the West, where a corresponding figure would be 3 cents per gal, the fuel cost would be about 0.35 cent per rail hp-hr.

In comparison, a Diesel-electric locomotive, using fuel oil at 6 cents per gal would have a fuel cost of about 0.43 cent per rail hp hr, which for eastern railroads would be better than the foregoing but not as good as for western roads. A 4000-hp coal-burning locomotive gas turbine of the multistage reaction type, operating at 1300 F with a regenerator, has an expected shaft thermal efficiency of 24 per cent. This unit proposed for the Locomotive Development Committee will have a contemplated fuel cost of 0.19 cent per rail hp-hr, which demonstrates adequately the desirability of using solid fuel.

There are other incentives for using coal as a locomotive fuel. One of these is that the chief source of revenue of some railroads is obtained from hauling coal, and good customer relations, obviously, are important. From a conservation standpoint the use of coal is also dictated. It is generally believed that coal reserves will last about 3000 years as compared with 15 years for oil. Even if the latter figure is appreciably in error, the overwhelming difference in favor of coal is manifest.

While it is planned to use liquid fuel, in the event that an attempt is ever made to burn coal, it may be found that the particular turbine design described in the paper may preclude this being accomplished successfully. In laboratory tests conducted for the Locomotive Development Committee at the Gas Institute of the Illinois Institute of Technology, it was observed that excessive blade erosion occurred when the relative velocity entering the blades exceeded 500 fps, even though the ash-separating equipment was operating at an efficiency of about 90 per cent. In a multistage reaction-turbine design the velocity can be kept within this value. Calculations performed by the writer, based on Fig. 3 of the paper, however, indicate that the relative velocity entering the first row of blades is approximately 850 fps, so prohibitive blade erosion may be encountered if the unit is ever modified to burn solid fuels. In fact, at this velocity some tendency toward blade erosion may be noted from the solid particles resulting from the heavy bunker C fuel oil.

Several advantages are claimed for the two-stage turbine described in the paper. It is stated that the first-stage blade temperature will be about 1160 F, compared with 1360 F if an eight-stage reaction turbine had been employed. It is believed pertinent, however, to mention that, from Fig. 3 of the paper, it would appear to the writer that the mean blade rotational velocity would be about 1050 fps, whereas for the reaction turbine the corresponding figure would be approximately 600 fps. Thus the blade stress in the latter case would be appreciably less, and, even though the blade temperature is higher, the factor of safety could compare favorably. In this connection, a proposed locomotive gas turbine of the reaction type has an average stress factor of safety of 2, based on the stress-rupture value of the material at 10,000 hr and the operating temperature. It would be of interest to know the corresponding figure for the subject turbine.

If a multistage reaction turbine with a regenerator were employed, the stated efficiency of 17 per cent could be obtained with a turbine-inlet temperature several hundred degrees below 1400 F. In such a case, the temperature of the reaction blading would be lower than the 1160 F figure and, since the rotational velocity would be reduced, the resulting stresses would be less, and the factor of safety higher than the values which would exist for the type of design described in the paper.

As mentioned previously, the gas turbine described in the paper is exemplary in its simplicity. Means for improving the efficiency of the cycle by incorporating such devices as regenerators, etc., were not adopted so as to avoid complications and obtain a simplified cycle with reduced maintenance. Because of the resulting simple cycle and impulse-type turbine, however, in order to obtain an acceptable thermal efficiency of 17 per cent, it is necessary to employ a turbine inlet temperature of 1400 F. As stated, the same efficiency could be achieved with a regenerator (a stationary piece of equipment of relatively low temperature and maintenance), and a multistage reaction turbine having an inlet temperature of several hundred degrees lower. Since increased maintenance is usually associated with higher temperatures (even though they be confined largely to stationary elements such as nozzles and combustion chambers), the seeming paradox may exist where an attempt to achieve simplicity may affect reliability adversely. Only after actual operating experience,

[1] Director, Department of Mechanical Engineering, Illinois Institute of Technology, Chicago, Ill. Mem. ASME.

[2] "Design Features of a 4800-Hp Locomotive Gas-Turbine Power Plant," by Alan Howard, Mechanical Engineering, vol. 70, April, 1948, pp. 301–306.

however, will full enlightenment regarding this matter be obtained.

The gas-turbine unit described in the paper has many exceptionally clever features of design. Obviously, much creative effort has been expended in arriving at the final product, and the designers are to be congratulated on their achievement. The type of design proposed has many advantages, as mentioned in the paper, and tests on the unit are awaited with interest.

AUTHOR'S CLOSURE

Dr. Rettaliata has presented an interesting discussion which illustrates the wide variation in opinion and designs in the gas-turbine field. In particular, he points out the desirability of an improved thermal efficiency on a locomotive and the desirability of the use of inexpensive fuel such as coal. There is, of course, no doubt of the desirability of burning coal, and it is hoped this can be achieved within a reasonable period of time. The design of the unit described in the paper has given consideration to this fuel and major difficulties with it would not be anticipated.

As noted in the paper, the use of a regenerator was given very careful study. Considering the cost, weight, and space it was estimated not to be desirable at present, particularly considering simplicity. These space and weight considerations are particularly important in a unit of the high power of the present one which is very substantially larger than any units on which regenerators are being considered in locomotives. It would be quite possible, as Dr. Rettaliata suggests, to make a unit of equal efficiency with a regenerator at a somewhat lower temperature. However, the air flow and therefore the size of all the equipment would have to be very substantially increased which would make it essentially impossible to put a unit of this high rating in a locomotive. Of course, we fully anticipate that as development and experience proceeds, the present efficiency of the unit will be improved.

Dr. Rettaliata discusses the turbine-bucket stresses in relation to temperature. In the present unit, the factor of safety on the basis he discusses is somewhat higher than the figure of two he mentions. Even if the factor of safety were the same, we would feel that substantially lower temperature for the material, subjected to the generally severe conditions under which a bucket operates, is definitely desirable.

Factors such as erosion, corrosion, temperature shock conditions, fatigue strength, wheel-rim temperature, and expansions to be allowed for, are all substantially benefited by a lower temperature.

ALAN HOWARD.[3]

[3] Division Engineer, Gas Turbine Engineering Division, General Electric Company, Schenectady, N. Y. Mem. ASME.

Code Restrictions on Welding

TO THE EDITOR

In the April, 1948, issue of MECHANICAL ENGINEERING, there appeared a letter signed by J. F. Lincoln, president of the Lincoln Electric Company, which is entitled to recognition as an effort to improve Code Rules for the construction of welded pressure vessels.

I offer the premise that Code writers are just as intent upon formulating the least restrictive rules consistent with safety, as the manufacturers of equipment are intent upon doing an honest job in proving and selling their products. If there is any "cussedness" in the make-up of any group, I believe it is sporadic and that it can be ignored in debating issues which are to be decided solely on their merits.

I infer that, in adding his general remarks, Mr. Lincoln was thinking about all types of welded structures, even though at several places pressure vessels are definitely mentioned.

Not to extend this letter unduly, I merely cite as part of the background for present rules, extensive published results of tests, and the most excellent work done by Mr. Lincoln's own experienced engineers and technicians. Their specialized leadership and experience in the four phases of arc-welding advancement—research, manufacture, application aid, and educational work—are expressed in the Lincoln Electric Company's "Procedure Handbook of Arc-Welding Design and Practice".

It would appear from the manner in which Mr. Lincoln's viewpoint is presented that he was only outlining a comparison on quality and a seeming prejudice in choice as between a welded and a riveted joint. Broadly speaking, under these two classifications only, it has been the idea of almost all engineers I know that the welded joint is preferred for pressure vessels, subject to adequate specifications for material, rules for construction, and qualified inspection all along the line, for which we, as engineers, are willing to approve the cost.

In a general comparison between riveted and welded work—and the writer has had experience with both, from early practices when hand operations in riveted work were quite common, and from the beginning of electric fusion welding—may we not recognize that riveting is now more or less a machine job, except for inspection? Its fabrication makes use of repetitive methods that cannot but result in the best type of workmanship, and a uniformity that meets the accepted method of computation.

On the contrary, welding is still largely a manual operation, dependent upon quality of workmanship, and therefore upon the individual skill and integrity of the welding operator, foreman, and inspector.

As to the nine items of comparison between the welded joint and the riveted joint which Mr. Lincoln cites, they should be valued in proportion to their relative importance. It is usually conceded that the breaking strength in a pull test on mill specimens is not the principal quality desired, because of the many variables that may be introduced, from the time that the steel is in the making until the vessel has been in service for a time. Quality of finished welds as regards ductility, fatigue value, and tendency to resist corrosion of any type, may be important and is dependent on the quality of the base material as well as the procedure used in welding.

Some defects in welds, which Mr. Lincoln merely lists in his letter, may alone be of little consequence but, in combination with others and service factors, may cause trouble.

Under defects limited by Code Rules may be classed lack of fusion, incomplete penetration where it is barred, gas pockets and slag inclusions, and surface appearance. Undercutting is barely mentioned in construction codes, as "practically none" is a recommendation only. In general, slight undercuts are not a cause for rejection. Serious examples of porosity may not be as indicated by the present ASME standard films, but user demand has largely set the present requirements.

As methods of examination improve, and instrumental indications of a nondestructive kind give greater assurance of having the minimum soundness and ductility in a welded joint in accordance with its efficiency rating, we can expect more liberalized standards to be set up. Mr. Lincoln's staff is well aware of all such developments in technique and is obviously interested in improving them.

In summary, I advocate the writing of rules to produce safe structures at minimum cost. Doubtless this is Mr. Lincoln's objective, too. Its attainment

will surely require mutual effort, compromise, and the test of time.

In my capacity as chairman of several Unfired Pressure Vessel Committees, including the Pressure Vessel Research Committee, and having helped to write codes for pressure vessels, I am hereby extending an invitation to Mr. Lincoln for an oral discussion on this subject, to the end that we may reach a common understanding of mutual problems. At the same time, if it is necessary to do some more research work to resolve some of these questions, I feel that he will recognize this need, and gladly join in any coöperative effort to discover what the industry at large now lacks.

WALTER SAMANS.[4]

[4] Chairman, Pressure Vessel Research Committee; Chairman, Sub-Committee on Unfired Pressure Vessels of the Boiler Code Committee, ASME; Chairman, Joint API-ASME Committee on Unfired Pressure Vessels.

Engineering for Aluminum-Alloy Castings

COMMENT BY FLORENCE F. BUCKLAND[5]

The following nomenclature is used in the discussion of this paper:[6]

A = area of casting, sq ft
b = distance from surface of mold, ft
c = specific heat, Btu/lb deg F
k = thermal conductivity, Btu/hr sq ft deg F/ft
M = strength of the instantaneous plane source
Q = quantity of heat liberated in the plane $x - x'$ per unit area
t = temperature at any time τ
t_0 = initial temperature of mold, deg F
t_b = pouring temperature, deg F
x = position of surface of mold
x' = distance from surface of mold, ft
V = volume of the casting, cu ft
α = thermal diffusivity, $k/\rho c$, sq ft/hr
ρ = density, lb per cu ft
τ = time, hr

The authors of this paper show very clearly what the factors are that influence the soundness of castings, and indicate that casting is an art as well as a science. They give a comprehensive account of the difficulties which may be encountered, and of ways for overcoming these difficulties.

In their discussion of the casting process, they emphasize the importance of controlling the rate of solidification. This can be controlled as indicated in the paper by varying the mold material, geometry, and size. It is the writer's impression that such controls are found by experience and by cut-and-try methods. However, there is a mathematical means, which may be useful in estimating the effect of mold changes on rate of solidification, and thus in reducing the number of trials required for a solution of a casting problem.

[5] General Engineering and Consulting Laboratory, General Electric Company, Schenectady, N. Y.

[6] "Engineering for Aluminum-Alloy Castings," by T. R. Gauthier and H. J. Rowe, MECHANICAL ENGINEERING, vol. 70, June, 1948, pp. 515–518.

It is possible to calculate the temperature at the surface of a mold; the temperature at the surface of the casting may be considered to be the same, if the drop through the vapor film at the surface is neglected. The shape of the mold must be approximated by a simple geometrical shape.

The analytical approach to the problem has been given elsewhere[7,8]. Mathematically,[4] the molten metal is considered an instantaneous plane source of strength M, heating an infinite slab, made up of the mold material, of diffusivity α. The cooling rate of a casting is influenced substantially by the mold material. The property, or combination of properties, which exerts the principal influence is the thermal diffusivity of the mold material, which is equal to the thermal conductivity divided by the product of density and specific heat, or

$$\alpha = \frac{k}{\rho c}$$

A material with high diffusivity, that is, high conductivity, low density, and low specific heat, will change its temperature more rapidly in response to external heating than a material of low diffusivity.

The equation giving the temperature in the mold at any time for mold diffusivity α is as follows

$$t - t_0 = \frac{M}{2\sqrt{\pi\alpha\tau}}\, e^{\frac{-(x-x')^2}{4\alpha\tau}}$$

where

$$M = \frac{Q}{\rho c} = \frac{V}{A}(t_b - t_0)$$

The time at which the temperature is a maximum for any position b is given by

$$\tau_{t\,\max} = \frac{b^2}{2\alpha}$$

These equations are plotted in Figs. 1, 2, and 3 of this discussion.

To exemplify the use of the first equation, take the case of a $^1/_4$-in. slab of 5 per cent silicon aluminum poured at 1340 F into a sand mold at 70 F.

Given: For sand

k = 0.2 Btu/hr sq ft deg F/ft
ρ = 101 lb per cu ft
c = 0.195 Btu/lb deg F

For the aluminum alloy

ρ = 166 lb per cu ft
c = 0.224 Btu/lb deg F

Solution:

$$\alpha = k/\rho c = \frac{0.2}{101 \times 0.195} = 0.0103$$

$$\frac{V}{A} = 0.25 \text{ in.}$$

$$Q = \rho c \frac{V}{A}(t_b - t_0) = 166 \times 0.224 \times \frac{0.25}{12}(1340 - 70) = 984 \text{ Btu per sq ft}$$

$$M = \frac{V}{A}(t_b - t_0) = \frac{0.25}{12}(1340 - 70) = 26.5 \text{ deg F} \times \text{ft}$$

The alloy solidifies at 1070 F. The time for the casting surface to reach this temperature is obtained by putting $x = x'$ in the first equation, thus obtaining

$$t - t_0 = 1070 - 70 = \frac{26.5}{2\sqrt{0.0103\pi\tau}}$$

[7] "Conduction of Heat in Solids," by H. S. Carslaw and J. C. Jaeger, Clarendon Press, London, England, 1947, p. 219.

[8] "Heat Transfer Notes," by L. M. K. Boelter, V. H. Cherry, H. A. Johnson, and R. C. Martinelli, University of California Press, Berkeley, Calif., 1946, chap. 7, pp. 9–10.

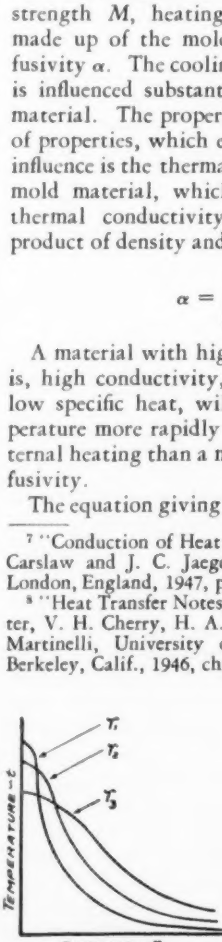


FIG. 1

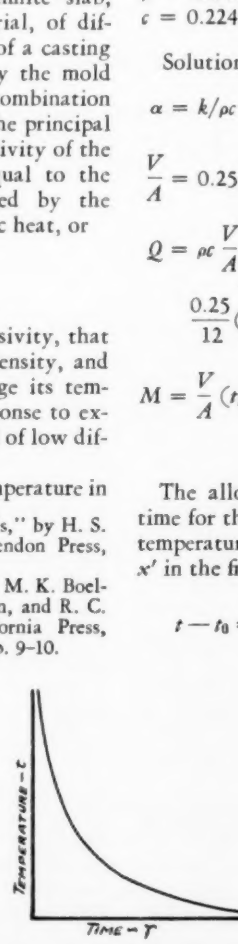


FIG. 2

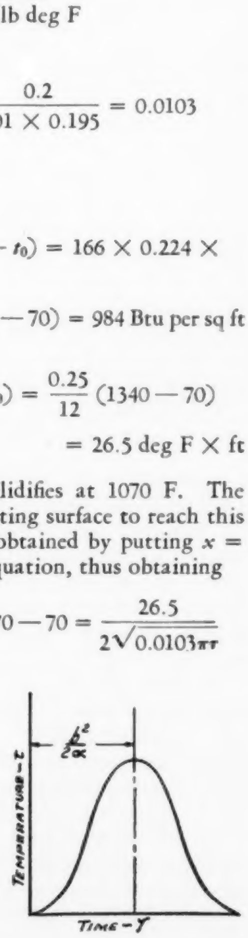


FIG. 3

$$\tau = \frac{1}{0.0103\,\pi}\left[\frac{26.5}{2 \times 1000}\right]^2 = 0.00551 \text{ hr,}$$

or 0.331 min

This calculation neglects heat of fusion and evaporation of binder from sand.

Now suppose we change the diffusivity, by changing the binder, to double, or 0.0206. The time to solidify the metal is now one half, or 0.166 min.

This means that by proper adjustment of the properties of the mold, the time for cooling various parts of the casting can be varied to suit the desired cooling rate.

A test program to determine relative diffusivities of sands of different sizes with various binders, organic and inorganic, would be useful. The determination might be made by ascertaining k, ρ, and c, or by making up cylindrical samples with thermocouples embedded in the centers, immersing the samples in molten metal, and reading the temperatures as functions of time.

Authors' Closure

The authors appreciate the excellent comments of Mrs. Buckland since it is believed the mathematical approach to the problem of controlling the rate of solidification of castings will be useful to the foundry industry. The basic principle of changing the thermal properties of a mold in specific locations in order to accomplish the desired directional solidification of a casting is not entirely new. The foundryman has used, for many years, numerous expedients to approach good directional solidification in castings. Mold chill inserts located at specific areas in the mold have been utilized for this purpose. Such chills may vary in size and form as desired and may be fabricated from various materials such as iron, copper, or aluminum, each having its own thermal properties. Other efforts have been made to vary the thermal properties of the mold itself, such as utilizing steel shot, suitably bonded, in certain locations of the mold to provide a higher thermal diffusivity. Other materials, such as a formed refractory material, can be molded as an insert in a mold to provide a lower diffusivity.

It is recognized that the foundryman has not, until recent years, approached his problem on a mathematical basis as suggested by Mrs. Buckland. One apparent disadvantage of changing the thermal properties of the mold in various locations, by utilizing molding materials with different diffusivities, is an increase in the cost of producing the castings. The authors are quite confident, however, that the foundry industry is anxious to approach this problem in a scientific manner.

The American Foundrymen's Association has considered the general problem of heat transfer in castings through studies conducted by a Heat Transfer Committee. Reference to their approach of this problem may be reviewed in the Transactions of the American Foundrymen's Association, vol. 55, pp. 53–76, 1947.

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H. J. Rowe.[10]

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REVIEWS OF BOOKS

And Notes on Books Received in the Engineering Societies Library

The Fracture of Metals

The Fracture of Metals. By M. Gensamer, E. Saibel, J. T. Ransom, and R. E. Lowrie. American Welding Society, New York, N. Y., 1947. Paper, 6 × 9 in., 84 pp., $1.

Reviewed by A. B. Bagsar[1]

THIS book is a critical survey of the literature and theories on fracture of metals, comprising two reports prepared for the Navy Department and later released for publication. The first report, Part I of the book, covers the field up to about 1944; the second report, designated Part II, supplements the first report and brings the subject up to about the beginning of 1947. It is a welcome reference book on the subject, and carries an extensive bibliography.

The foregoing reports were apparently intended to enumerate and discuss the various conflicting theories and phases in the fields of fracture and plastic flow of metals, and to emphasize those which need investigation and deciphering. The average engineer unfamiliar with the subject may find the book a little difficult to follow. Nevertheless, the book can serve as a good reference for research workers and students of the subject, despite the fact that considerable new and enlightening data have been published since the preparation of these reports.

Although extensive experimental work and investigations have been made on fracture of metals during the past sixty years or so, and numerous theories have been advanced to formulate the mechanism of this phenomenon, no single theory appears to be capable of explaining all test observations. In some respects, our knowledge of the mechanism of fracture of metals can therefore be considered to be in its embryonic stage. This situation is clearly brought out in the book. However, certain trends have been established. Following is given a brief description of the status of the present knowledge on fractures and deformation of metals as covered by the book, supplemented by data published recently.

Two primary types of fracture are recognized: the brittle or cleavage type, and the ductile or shear type. For the sake of simplicity, it could be stated that cleavage fractures develop by separation of the metal along certain cleavage planes, whereas the shear fractures develop by sliding of one part over the other to the point where separation or failure occurs. Cleavage fractures appear suddenly as a critical stress level is reached and propagate rapidly without showing any appreciable permanent deformation. Shear fractures, on the other hand, appear and progress slowly and show considerable permanent deformation. Steel can be made to fracture by either one of these modes, depending on conditions of stress concentration or state of stress, temperature, metallurgical treatments, and several

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other variables. Rigidity or restraint to lateral flow, low temperatures, and in some cases rapid rate of load application favor fracturing of steel by the cleavage mode. Failure of numerous all-welded ships and pressure vessels has been by the cleavage mode.

Although in appearance these two types of fracture are markedly different from each other, recent work has indicated the possibility of correlating them with each other, and of evaluating the conditions under which transition occurs from one mode of fracturing to the other. Fracturing of metals by pure tension, as well as by shearing, appears to be expressible by the parabolic relationships: $S = KD^n$, in which S is the breaking or yield stress, as the case may be, n and K are constants for a given material in a given condition, and D is a variable such as temperature, state of stress, anisotropy, strain rate, etc. In brittle fractures the yield stress is raised almost to coincide with the breaking stress so that no appreciable yielding occurs. In ductile fractures, failure occurs mostly by shear or yielding. The *actual* stress for cleavage fracturing is several times greater than the stress required to cause shearing. However, in the presence of inherent discontinuities or defects in the metal or those introduced by faulty design or workmanship, a state of triaxial stress may be created which induces severe stress concentrations and thereby lowers the *nominal* stress required for brittle fracturing to levels considerably below the yield stress.

Several engineering criteria of fracturing have been advanced. These include the maximum principal stress, maximum shear stress, maximum shear strain energy theories, each of which theory has its modifications. The maximum principal or normal stress theory appears to apply mainly to brittle fractures. The shear stress and shear strain energy theories seem to find their most usefulness in the fields of permanent deformation and ductile fractures. Brittle fractures occur as soon as a critical level of tensile stress is reached, whereas shear fractures occur when the maximum shear stress or shear strain energy values are reached.

Several theories have also been advanced covering the mechanism of fracture and plastic flow, none of which has attained general acceptance. The microcrack theory is one of these, which assumes that microcracks in the form of lattice discontinuities or structural weakness are inherently present in the material. Cracks propagate if energy is released by creation of new surfaces. This theory appears to apply to fracturing of brittle materials. The thermodynamic theory of fracture assumes that fracturing is analogous to melting, and makes use of certain physical constants derived from the volumetric and energy changes associated with melting, to compute fracture strengths. A third, the dislocation theory, postulates that plastic deformation or the slip process does not consist of a rigid motion of atomic planes relative to one another, but that it involves lattice distortions or imperfections on an atomic scale. Attempts have been made to apply the latter theory in the fields of plastic deformation, work and precipitation hardening, creep, etc. Each of these theories likewise has variants and modifications. There are several other theories, somewhat limited in scope, than the foregoing theories, which are too numerous to describe in this brief summary.

A wide discrepancy exists between the observed values of breaking strength of metals and their respective cohesive strength, computed from theoretical considerations of interatomic forces and other data. On the basis of theoretical computations, the strength of metals should be one hundred to one thousand times greater than the experimentally observed strength values. Several explanations have been offered to account for this discrepancy, none of which has been generally accepted.

Saga in Steel and Concrete

SAGA IN STEEL AND CONCRETE. By Kenneth Bjork. Norwegian-American Historical Association, Northfield, Minn., 1947. Cloth, $5^7/_8 \times 9$ in., 504 pp., illus., $4.

REVIEWED BY ARTHUR M. GREENE, JR.[2]

As illustrating the successful use of the opportunities in the United States of America for service and advancement to men of vision and ability through training in the fundamentals of science and engineering in a land of lesser opportunities and the contributions of these men of foreign birth to the development of America, this full record of the activities of Norwegian engineers, architects, and technical men in our country by Professor Bjork is a valuable historical document and an inspiration to any reader.

The book was written after eight years of study at the request of the Norwegian-American Historical Association and the editors of the Norwegian language newspapers of the United States. It is based not only on the records of the Association but on the careful study of the archives and Journal of the Norwegian-American Technical Society, many publications of the United States and of Norway, and the consultations with and by assistance from others of Norwegian origin about personal data and engineering procedures and methods. To many of these helpers credit is given in the excellent preface and the extensive footnotes throughout the text give the printed sources on which parts of the saga are based.

The first chapter, "The Migration of Skills" which refers primarily to the immigration of these engineers to America from 1860 to 1929, discusses the technical developments of the eighteenth century in the British Isles, and the migration of skills to Norway in the next century leading to the establishment of the Norwegian Schools at Horten (1855), Trondhjem (1870 and 1910), Christiania (1873), Bergen (1875), and Porsgrund (1884). The growth of these schools and the studies of these men to whom America owes much from the early days to the later ones are discussed, as well as their enrollment and the numbers who migrated in different years from 1860 to 1933, as well as those returning to Scandinavia from 1908 to 1940. The conditions in America which attracted these men and presented to them the opportunities for advancement are described.

The second chapter, "Pioneering the Technical Fronts," deals with special work of some of the early immigrants to the West, while in "A Philadelphia Story" (chapter 3), the experiences of three Horten men, Olsen, Loss, and Indahl, are given in much detail.

This is followed by ten chapters: "Spanning American Rivers," "A Revolution in Tunneling," "Building to the Skies," "Men in Metallurgy," "Putting Science Into Production," "Of Power, Paper and Ships," "Engineers and Engineering," "Machines: Their Makers and Masters," and "Architects, Scholars, and Chemists." In each of these the author discusses the work of many Norwegians, their contributions, their progress, their interests, and their associates, superiors, and assistants. Their works are described, and where necessary, the principles used by them are discussed. In these chapters we learn something of the personalities and professional lives of many Norwegian technical men such as Barth, Pihlfeldt,

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Hoff, Singstad, Dahm, Aus, Berle, Gundersen, Cappelen Smith, Berg, Storm Bull, Asserson, Evinrude, and Ruud.

The chapter, "The Engineers Organize," not only is the saga of the Norwegian-American Engineering Societies of the present century but it describes the clubs and the organizations of the earlier times to meet the social and cultural needs of the men of Norwegian birth in this newly adopted land. It tells of the aid given to the new men by their countrymen who had succeeded on this side of the Atlantic.

The final excellent chapter, "Toward a Social Philosophy," treats of the economic developments of our times and the role of the engineer at this period, his education, his work, his incentives, and his prejudices, comparing the Norwegians and Americans of the last century with those of the present. The changes in educational requirements are discussed as well as the contributions of Norwegian-American engineers to economic theory and labor-management relations.

The book is based on a thorough study of much original material and it gives credit to the engineer of foreign training in ably adapting this to American conditions and working with American engineers and employers or clients with faithfulness and co-operation. It is well-written and the dry facts are enlivened by discussions of principles and descriptions of methods used to overcome difficulties. The reviewer especially commends the excellent and clear use of the vast amount of material at hand for the saga, as well as the most complete index.

The format and its execution, especially the illustrations, are of high order.

Symbols, Signs, and Abbreviations

SCIENTIFIC AND TECHNICAL ABBREVIATIONS, SIGNS AND SYMBOLS, by O. T. Zimmerman and Irvine Lavine, Industrial Research Service, Dover, N. H. Cloth, $5^3/_4 \times 8^1/_4$ in., 476 pages, $7.50.

If there is one characteristic of scientific and engineering literature which disdistinguishes it from other writing, it is the dependence on abbreviations, signs, and symbols for economy in conveying information. Without these devices careful reading in mathematical and engineering literature would be a laborious task indeed.

In each body of scientific literature, constant use of words and phrases denoting scientific relationships develops a familiarity out of which are generated time-saving abbreviations, signs, and symbols by which entities and directives are easily identified. The usefulness of this shorthand technique remains in force only as long as the writer and reader understand the common practice. Unfortunately, each body of science independently arrived at its own scientific shorthand. One abbreviation or symbol may have two or more meanings, thus creating a difficulty for the reader who finds it necessary to enter an unfamiliar literature.

The ASME and other engineering agencies have long recognized this limitation and have made available to the profession lists of recommended abbreviations, signs, and symbols as an aid in bringing writer and reader together. By co-ordinating standardization in this field, the American Standards Association has done some of its most significant work.

The book under review is a compendium of abbreviations for writers and readers in science and engineering. It places between the covers of a single volume all the abbreviations and symbols compiled by the Sectional Committee Z10, on Letter Symbols and Abbreviations for Science and Engineering of the American Standards Association and recommended lists of other agencies who have done work in this field. Because it brings together abbreviations and symbols in such diversified fields as engineering, mathematics, chemistry, hydrography, meteorology, thermodynamics, aeronautics, radio, electronics, medicine, commerce and banking, machine and tool shops, and many others, this book should exert a beneficial force in the direction of general acceptance of recommended abbreviations by authors who otherwise would not have occasion to consult lists in pamphlet form. It should also serve to indicate the need that still exists for co-ordinating and integrating the work of groups that have given attention to this field of standardization.

Abbreviations strangely enough, form powerful citadels for those who have accepted particular terms by tradition or habitual use. Engineers are likely to become heated in discussions which threaten to modify or change a favored practice. For years the storm has raged over the period in abbreviations. The ASME and the ASA recommended in 1941 that the period be dropped. As a concession to those who strenuously resisted such a heresy, the period was allowed in such abbreviations as that of the word "inch" which is "in." and which if written without the period might be confused with the preposition.

Recently, one of the protagonists of the period made a point by citing an example from the literature where the lack of period and the human failing of pronouncing any concatenation of Latin letters, led an author to use the Greek letter psi (ψ) as the abbreviation of psi (pounds per square inch).

In this book, however, the authors throw their weight against the period. In fact, they go farther than the ASA by recommending elimination of all periods except where use of a period would definitely contribute to clarity.

The profession has much to gain by standardizing on the use of abbreviations. This book is a welcome addition to the literature not only because it will encourage uniformity, but because in itself it is a useful tool for readers and writers in science.

A. F. B.

Books Received in Library

ASTM STANDARDS INCLUDING TENTATIVES, 1947 Supplement, 5 Parts. Part 1-A, Ferrous Metals, 403 pp. Part 1-B, Nonferrous Metals 319 pp. Part 2, Nonmetallic Materials—Constructional, 463 pp. Part 3-A, Nonmetallic Materials—Fuels, Petroleum, Aromatic Hydrocarbons, Soaps, Water, Textiles, 437 pp. Part 3-B, Nonmetallic Materials—Electrical Insulation, Plastics, Rubber, Paper, Shipping Containers, Adhesives, 305 pp. American Society for Testing Materials, Philadelphia, Pa., 1947–1948. Paper, 6×9 in., illus., diagrams, charts, maps, tables, $4 each. These supplements give in their latest approved form some 330 specifications, tests, and definitions which were either issued for the first time in 1947 or revised since their appearance in the 1946 Book. The five separate parts correspond to the division of the triennially published complete Book of ASTM Standards: ferrous metals; nonferrous metals; nonmetallic materials—constructional; and two parts covering other nonmetallic materials, such as fuels, soaps, textiles, insulation, plastics, rubber, paper, etc.

GERMAN ENGINEERS' TOOL INDUSTRY. By C. H. Booth and Associates, Mapleton House, 5415 Seventeenth Ave., Brooklyn 4, N. Y., 1947. Paper, $5^1/_2 \times 8^1/_2$ in., 200 pp., illus., diagrams, tables, $10. Prepared by the British Intelligence Objectives Committee, this survey presents individual reports on various types of tools as well as the general report. Appendixes contain tables, diagrams, and pictures of tools and machines. Summaries of the individual "target" reports are given.

KINEMATICS OF MACHINES. By L. M. Sahag. Ronald Press Company, New York, N. Y., 1948. Cloth, $6 \times 9^1/_2$ in., 249 pp., illus., diagrams, $4. Following introductory chapters on fundamental conceptions and motion in machines, the text is divided into separate detailed discussions of the particular actions and mechanisms dealt with, such as: instant centers, linear and angular velocities, cams, gears, flexible links, etc. In the solution of problems in velocities and accelerations the graphic method has been applied in preference to the analytic method.

MODERN METALLURGY FOR ENGINEERS. By F. T. Sisco. Second edition. Pitman Publishing Corporation, New York, N. Y., and London, England, 1948. Cloth, 6 × 9½ in., 499 pp., illus., diagrams, charts, $5. This revision of a widely used textbook is of primary interest to engineers concerned with the relation of metals and metallic alloys to structures and machines. It contains information on the origin, production, composition, and properties of most of the metals used in modern engineering. Various forms of heat-treatment are explained with particular reference to practical difficulties encountered. Considerable attention is given to hardenability of steel. There are many illustrations, a series of questions on the subject matter of each chapter, and useful suggestions for further reading.

MODERN PLYWOOD. By T. D. Perry. Second edition. Pitman Publishing Corporation, New York, N. Y., and London, England, 1948. Cloth 6 × 9¼ in., 458 pp., illus., diagrams, charts, tables, $6. This book covers the manufacture, design features, physical characteristics, and commercial applications of plywood. It also presents extensive technical data and testing procedures. New material in this second edition includes barking logs, reeling green veneer, plymetal, sandwich constructions, aircraft and marine plywood, molded versus formed plywood, progressive gluing, scarf jointing, and radio-frequency and resistance heating. A bibliography and a glossary of terms are included.

PRACTICAL JOB EVALUATION. By P. W. Jones. John Wiley & Sons, Inc., New York, N. Y.; Chapman & Hall, Ltd., London, England, 1948. Cloth, 5½ × 8¾ in., 304 pp., illus., diagrams, charts, tables, $4. Describing the applications of wage determination to wage structures, this book emphasizes the design, installation, and salesmanship of the procedures necessary to determine the wages of employees. All plans and techniques included have been used successfully in business and in industry.

PRECISION INVESTMENT CASTINGS. By E. L. Cady. Reinhold Publishing Corporation, New York, N. Y., 1948. Cloth, 6 × 9¼ in., 356 pp., illus., diagrams, charts, tables, $6. This treatment of a relatively new production process tells in the first few chapters what the process is, what it does, and how it does it. Subsequent chapters detail the practical methods for getting the best results and show how the process operates to obtain the desired ends. The resources and weaknesses of the process are described, and future developments are indicated.

PRODUCTION COST TRENDS IN SELECTED INDUSTRIAL AREAS. By P. Neff, L. C. Baum, and G. E. Heilman. University of California Press, Berkeley and Los Angeles, Calif., 1948. Cloth, 6 × 9½ in., 249 pp., charts, tables, $4. This statistical study compares manufacturing cost trends in the industrial areas of Los Angeles, San Francisco, Detroit, Cleveland, Chicago, and Pittsburgh for the period 1929–1939. The trends in general manufacturing are first considered; then durable goods, such as food, textiles, paper, rubber products, etc.; and finally a number of selected industries are dealt with. The data utilized are taken mainly from the U. S. Census of Manufactures.

SAMPLING INSPECTION by the Statistical Research Group, Columbia University. Edited by H. A. Freeman and others. McGraw-Hill Book Co., Inc., New York, N. Y., and London, England, 1948. Cloth, 6 × 9¼ in., 395 pp., charts, tables, $5.25. This authoritative work deals first with the elementary concepts of acceptance sampling, supplies a standard sampling-inspection plan, and gives detailed instructions so that the principles developed and the plans provided can be used for practical inspection of industrial products. In addition to providing single, double, and sequential plans for various AQL classes, for use with any lot sizes, the operating characteristic of each plan is provided.

SINTERED IRON AND STEEL COMPONENTS, PB 46386. By C. J. Leadbeater. Mapleton House, Brooklyn, N. Y., 1947. Paper, 5½ × 8¼ in., 61 pp., illus., diagrams, tables, $3.50. This report presents descriptive information and tabular data on the products and work of five German powder metallurgy plants. Special topics dealt with include sintered iron driving bands, bullet cores, and sintered steel products.

SUPERCHARGING THE INTERNAL COMBUSTION ENGINE. By E. T. Vincent. McGraw-Hill Book Company, Inc., New York, N. Y., Toronto, Can., London, Eng., 1948. 6 × 9½ in., 315 pp., illus., diagrams, charts, tables, $5. This book presents the essential fundamental theory of the various forms of superchargers and turbosuperchargers in use today, together with effects on the engine cycles, power outputs, and thermal efficiencies. Design data for the centrifugal and turbosuperchargers are included, with descriptions of constant and variable-speed drives and the effects of different altitudes on the aircraft engine. A method is given for analyzing the Otto cycle to allow for the varying heat loss to the cooling medium. The elements of supercharging the oil engine are also considered.

TABLES FOR THE DESIGN OF MISSILES. (Annals of the Computation Laboratory of Harvard University, vol. 17.) Harvard University Press, Cambridge, Mass., 1948. Cloth, 7¾ × 10¾ in., 226 pp., diagrams, tables, $9. These tables were made to facilitate the design of missiles by permitting rapid calculation of the characteristics of the quantities affecting the behavior of a missile in flight. In the introduction, definitions of the tabulated functions, the method of computation, interpolation instructions, the use of the tables, and nonstandard ogives are considered. The major portion of the book contains complete tables of important functions with sufficiently small increments for precise work.

THEORY OF SERVOMECHANISMS, edited by H. M. James, N. B. Nichols, and R. S. Phillips. (M.I.T. Radiation Laboratory Series, Vol. 25.) McGraw-Hill Book Co., New York, N. Y., Toronto, Canada, London, England, 1947. Cloth, 6 × 9¼ in., 375 pp., diagrams, charts, tables, $5. This book deals first with frequency-response techniques of servomechanism design. The required mathematical background is summarized and applications are described. The second section presents a new design technique, and the relationship of the two sections is discussed. The approach makes fundamental use of statistical methods. The book closes with an account of the applications of these techniques to servomechanisms operating with pulsed data.

Library Services

ENGINEERING Societies Library books may be borrowed by mail by ASME members for a small handling charge. The Library also prepares bibliographies, maintains search and photostat services, and can provide microfilm copies of any item in its collection. Address inquiries to Ralph H. Phelps, Director, Engineering Societies Library, 29 West 39th St., New York 18, N. Y.

ASME BOILER CODE

Interpretations

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Anyone desiring information on the application of the Code may communicate with the Committee Secretary, ASME, 29 West 39th St., New York 18, N. Y.

The procedure of the Committee in handling the Cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are then sent by the Secretary of the Committee to all members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and is passed upon at a regular meeting.

This interpretation is later submitted to the Council of The American Society of Mechanical Engineers for approval after which it is issued to the inquirer and simultaneously published in MECHANICAL ENGINEERING.

Following is a record of the interpretation of this Committee formulated at the meeting of June 25, 1948, and approved by the Council on August 10, 1948.

CASE No. 1074

(In the hands of the Committee)

CASE No. 1075

(Interpretation of Par. U-13h)

Inquiry: Is it permissible, under Par. U-13(**h**) of the Code, to use cast iron conforming to Specification SA-48 with a maximum sulphur content of 0.15 per cent?

Reply: It is the opinion of the Committee that cast iron with a sulphur content not over 0.15 per cent and with a manganese content of 0.75 per cent or higher, but otherwise complying with Specification SA-48, may be used under the provisions of Par. U-13(**h**) of the Code.

ASME NEWS

And Notes on Other Engineering Societies

Compiled and Edited by A. F. Bochenek

1948 ASME Annual Meeting to Be Held at Pennsylvania Hotel, New York, N. Y., Nov. 28–Dec. 3

THE 1948 Annual Meeting of The American Society of Mechanical Engineers, to be held at the Pennsylvania Hotel, New York, N. Y., Nov. 28–Dec. 3, 1948, promises to match in size and quality the ASME Annual Meetings of 1946 and 1947.

Last year, for the first time in several years, the ASME broke the precedent of holding its most important meeting in New York, N. Y. The meeting was held instead at Atlantic City, N. J., where members found the facilities and the atmosphere so pleasing that a decision has been made to go to Atlantic City every four years.

Two years ago when the ASME staged its record annual meeting of 74 sessions and many luncheons and dinners, Hotel Pennsylvania served as headquarters. In spite of the misgivings of the management, who warned that their facilities were inadequate for a meeting of such size, the sessions were well managed and the dinners and luncheons were held on time, but the service was hard to administer because it was necessary to convert dining rooms into meeting rooms and meeting rooms back into dining rooms.

One of the major reasons for holding the meeting in New York in 1948 is the 1948 Power Show, known officially as the 18th National Exposition of Power and Mechanical Engineering, which will be staged in Grand Central Palace, New York, N. Y., Nov 29 to Dec. 4, 1948. Engineers who come to the Power Show will be able to participate in some of the Annual Meeting sessions.

70 Technical Sessions

Some idea of the wealth and variety of the 1948 Annual Meeting program may be had from the following list of professional divisions and committees who are planning 70 technical sessions: Applied Mechanics, Automatic Regulation Theory, Aviation, American Rocket Society, Boiler Feedwater Studies, Civic Responsibility, Education, Effect of Temperature on Properties of Metals, Fluid Meters, Fuels, Furnace Performance Factors, Gas Turbine Power, Heat Transfer, Hydraulic, Industrial Instruments and Regulators, Lubrication, Machine Design, Management, Materials Handling, Metal Cutting Data and Bibliography, Metals Engineering, Nuclear Energy, Oil and Gas Power, Petroleum, Power, Process Industries, Production Engineering, Properties of Gases and Gas Mixtures, Railroad, Rubber and Plastics, Safety, Strength of Vessels Under External Pressure, Textile, Wood Industries.

Members are advised that it is not too early to make reservations for the meeting. A block of rooms have been set aside for ASME members not only at the headquarters hotel, but also in other near-by hotels. These rooms will be assigned through reservation desk of the Pennsylvania Hotel.

Hotel Room Reservations

For Annual Meeting hotel rooms in the headquarters or near-by hotels, write to the Pennsylvania Hotel. The hotel must have essential information not later than Nov. 19, 1948. Please state type of room, name of occupants, expected time, date of arrival, and also departure.

Power Show in New York During ASME Annual Meeting Week

THE 1948 Power Show, officially known as the 18th National Exposition of Power and Mechanical Engineering, will occupy four floors in Grand Central Palace, New York, N. Y., during the week of the ASME 1948 Annual Meeting, November 29 to December 4, 1948.

Exhibits already enrolled and in preparation range over the entire field in a wide assortment from the firebox to the push button on the last motorized units in the plant. Included among the many new exhibits will be a comprehensive display by one of the world's largest producers of refractories, a new stoker shown for the first time, a well-known steam engine, and additional exhibits of self-contained burner-boiler units. New economies will be reflected in the long list of specialties, piping and valves, automatic recorders and controls, and instruments for many purposes. Improved construction will be featured in pumps and compressors, fuel and materials-handling equipment, variable transmissions and drives, as well as many other kinds of power and power-plant machinery.

As in the past, the ASME will have an exhibit of latest publications.

Pool Orders for 100,000 Machine Tools Recommended by NSRB Report

IN spite of the excellent condition of the American machine-tool industry with respect to capacity and stocks of tools in reserve, pool orders for 100,000 machine tools should be prepared immediately as a time-saving device in case of a national defense emergency, according to a recently declassified report covering significant aspects of the industry prepared by S. E. Reimel, Mem. ASME, and E. R. Henning for the National Security Resources Board.

The report is the result of several months of study during which leaders of the machine-tool industry and officials of the Armed Forces and the Government were consulted.

The conclusions were based on the assumption that war, if it comes, will be sudden and of a character not permitting gradual evolution of administration and control measures and that government and large industrial centers will be the object of immediate attack.

Tool Production Above Peacetime Needs

The study showed that the machine-tool industry is currently producing at about 50 per cent capacity and well above normal peacetime needs. The industry is well tooled and an increase of less than 25 per cent of World War II expansion would be sufficient to meet new defense requirements.

While the government has a reserve of approximately 90,000 machine tools with which to fill the gap between early requirements and the attainment of full wartime production by the industry, the quality of these tools is deteriorating rapidly because of the

delays in the preservation program at the storage centers.

Annual Review of Orders

To eliminate confusion in an emergency the report recommends that pool orders complete with all necessary forms be prepared and placed with tool builders for action the moment an emergency is declared. Annual review of the orders is suggested to keep orders in line with war plans and changes in machine-tool builders' capacities.

The report emphasized that the important consideration is not the exact magnitude of the pool orders, but the distribution of types and sizes of tools necessary to produce the character of munitions envisaged by the latest war plans.

For administration of the machine-tool program, the report recommends organization of a Plant Equipment Division of a future War Production Board of which the Machine Tool Section would form a part. This agency should be located away from any government center, preferably in some midwestern college town.

Lines of authority and definitions of responsibility should be drawn now for the Armed Forces, Ammunition Board, and the Machine Tool Section of the WPB to avoid conflicting directions, which in the early stages of an emergency tend to make for confusion.

Fourteenth National Applied Mechanics Conference Features Symposium on Plastic Flow

TWO hundred members and guests of The American Society of Mechanical Engineers met at the Illinois Institute of Technology, Chicago, Ill., June 17-19, 1948, to participate in the Fourteenth National Conference on Applied Mechanics. With the Illinois Institute of Technology and the Armour Research Foundation joining the Chicago Section of the ASME to act as hosts, the three-day meeting was highlighted by six technical sessions at which 24 papers were presented. The banquet scheduled for the evening of the second day was addressed by Frank Martinuzzi, director of gas-turbine research for the Italian National Research Council, Rome, Italy. Dr. Martinuzzi is the ASME 1948 Rice Lecturer. Meetings were held amid the modern surroundings of Technology Center at the Illinois Institute of Technology.

Special features of the meeting included a two-day symposium on flow and fracture of metals, held in co-operation with the ASME Special Research Committee on Plastic Flow of Metals, and a session conducted jointly with the American Society of Civil Engineers, Structural Division, Committee on Applied Mechanics. Tours were arranged to visit the facilities at the Institute and an active and enjoyable women's program was organized for the benefit of the visiting wives.

The first day of the meeting was devoted to papers dealing with elasticity, fluid mechanics, and vibrations. Three papers were presented covering the following subjects: (1) Flow of a compressible fluid through a series of identical orifices (48—APM-4);[1] (2) a study of the vibration of cantilever beams with prescribed end motion (48—APM-3);[1] (3) account of a polygonal approximation method, applied to the hodograph plane (48—APM-23),[2] which permits many difficult problems in the flow of compressible fluids to be resolved with relative convenience.

Two papers, one on isotropic turbulence (48—APM-5),[1] and the second on certain properties of matrixes as applied to structural analysis (48—APM-7)[1] were presented by title.

The afternoon session was sponsored jointly with the Committee on Applied Mechanics of the ASCE and dealt with solutions to various structural problems.

Symposium Is Well Attended

The remaining four sessions of the meeting were devoted to a Symposium on Flow and Fracture of Metals. The program for this symposium was arranged in co-operation with the ASME Special Research Committee on Plastic Flow of Metals, and special thanks are due to the chairman of that committee, A. L. Nadai, for his tireless effort and continuing interest.

Three papers presented at the first session discussed the following: (1) Description of experimental studies of biaxially stressed mild steel in the plastic range (48—APM-1);[1] (2) results of biaxial stress studies made on steel tubes (48—APM-20);[3] and (3) effect of size and stored energy on the fracture of tubular specimens (48—APM-12).[1]

The second session dealt with the theories of plasticity. The papers discussed: (1) some properties of a mechanical model which simulates plastic behavior (48—APM-10);[1] (2) a correct statement of the stress-strain laws of plasticity (48—APM-14);[1] (3) investigation of certain stress-strain relations for finite elasto-plastic deformations (48—APM-15);[3] (4) a generalized deformation law (48—APM-13);[1] and (5) proof of the principle of maximum plastic resistance (48—APM-2).[1]

Dr. Martinuzzi Addresses Banquet

At the banquet held on Friday evening, Dr. Martinuzzi gave the principal address. His main topic was the general status of gas-turbine developments in Europe, although he permitted himself many minor excursions into such channels as the general meaning of research, and the relative importance of research minds versus research facilities. Due to his remarkable style, Dr. Martinuzzi's talk emerged with equal interest to both the technical and nontechnical members of the audience. W. M. Murray, chairman of the Division, presided and brief welcoming addresses were given by H. T. Heald, president of the Institute and Armour Research Foundation, and T. S. McEwan, vice-president ASME Region VI.

The last day of sessions started with an analysis of the forces acting in tension impact

[1] A digest of this paper was published in the ASME Technical Digest section of MECHANICAL ENGINEERING, May, 1948, pages 452-454.

[2] This paper will be published in a future issue of the *Journal of Applied Mechanics*.

[3] A digest of this paper was published in the ASME Technical Digest section of MECHANICAL ENGINEERING, June, 1948, pages 549-550.

August News High Lights

THE ASME 1948 Annual Meeting is shaping into another record meeting. Pennsylvania Hotel will serve as headquarters. With the 1948 Power Show to be held during annual meeting week, good attendance is expected (778).

The Third Annual Conference on Petroleum Mechanical Engineering is expected to attract many engineers of the petroleum industry to Amarillo, Texas, early in October (781).

A symposium on woodworking research laboratories will be the feature of the Wood Industries Conference to be held at High Point, N. C. (782).

The annual joint conference of the ASME Fuels Division and the AIME Coal Division will hear E. G. Bailey, president ASME, discuss engineering opportunities in the field of fuels (780).

A successful Applied Mechanics Conference was held by the ASME Applied Mechanics Division at the Illinois Institute of Technology, Chicago, Ill., in June (779).

In spite of unsettled conditions in the Eastern Mediterranean, the World Engineering Conference is planning to hold its Second World Technical Congress at Cairo, March, 1949 (780).

Many matters of interest to the engineering profession are discussed in the ECPD 15th Annual Report recently published (780).

Publication of the *VDI Zeitschrift* was resumed in March, 1948 (783).

A NSRB study of the American machine tool industry recommends pool orders for 100,000 machine tools to meet production needs in case of a sudden national defense emergency (778).

A nation-wide survey of high prices based on increased production and transportation costs to be conducted by the ASME Management Division recently received wide attention in the press (783).

tests of materials (48—APM-18).[3] A new method for making high-speed compression tests on small copper cylinders was described next (48—APM-9).[1] Papers on the propagation of plasticity in uniaxial compression in an extension of some previous work (48—APM-17),[3] and the interaction of discontinuity surfaces in plastic fields of stress (48—APM-16)[3] concluded the session.

The last session of the meeting was devoted to plastic flow and fracture. The papers covered (1) a proposed law of work hardening (48—APM-6);[1] (2) results of an investigation into the influence of the dimensional factors on the mode of yielding and fracture in flat tensile bar specimens made from medium-carbon steel (48—APM-11);[1] (3) plastic deformation of circular steel diaphragms (48—APM-19);[3] and (4) a progress report on their work devoted to a study of the contact stresses in the rolling of metals.

At the close of the meeting an expression of thanks was extended on behalf of the Division to the Chicago-area hosts. It was their excellent work and careful planning which accounted in no small measure for the success of the meeting. A vote of appreciation was also offered to the various chairmen and recorders whose services made possible the smooth conduct of the technical sessions.—Reported by MARTIN GOLAND, *Secretary*, ASME Applied Mechanics Division.

ASME Calendar

of Coming Events

Sept. 7–9, 1948
ASME Fall Meeting, Reed College, Portland, Ore.

Sept. 13–17, 1948
ASME Instruments and Regulators Division Conference, Convention Hall, Philadelphia, Pa.

Sept. 20–21, 1948
ASME Aviation Division Conference, Engineers Club of Dayton, Dayton, Ohio.

Oct. 3–6, 1948
ASME Petroleum Division Conference, Herring Hotel, Amarillo, Texas.

Oct. 14–15, 1948
ASME Wood Industries Division Conference, Sheraton Hotel, High Point, N. C.

Nov. 3–4, 1948
ASME Fuels Division—AIME Coal Division Conference, Greenbrier Hotel, White Sulphur Springs, W. Va.

Nov. 28–Dec. 3, 1948
ASME Annual Meeting, Hotels Pennsylvania and New Yorker, New York, N. Y.

Jan. 10–14, 1949
ASME Materials Handling Division and Management Division Conference, Convention Hall, Philadelphia, Pa.

May 2–4, 1949
ASME Spring Meeting, New London, Conn.

WEC to Hold Congress in Cairo, March 20–26

THE Second International Technical Congress sponsored by the World Engineering Conference is being planned for Cairo, Egypt, March 20–26, 1949.

The following topics have been chosen for the Congress: Industrial raw materials and their rational utilization throughout the world; social aspects of technical development and of raw-materials problems; and the problem of water in the Middle East.

The World Engineering Conference was organized in September, 1946, at the First Technical Congress in Paris as an international clearing house for information and opinion from the world engineering profession.

Aristide Antoine of France is president of the WEC. Fenton B. Turck, Mem. ASME is serving as a vice-president.

ASME-AIME Fuels Conference to Be Held Nov. 3–4

PLANS are well along for the Eleventh Joint Fuels Conference sponsored by the Fuels Division of The American Society of Mechanical Engineers and the Coal Division of the American Institute of Mining and Metallurgical Engineers. The conference will be held at Greenbrier Hotel, White Sulphur Springs, W. Va., Nov. 3-4, 1948.

The AIME Central Appalachian Section is in charge of local arrangements.

E. G. Bailey has accepted an invitation to speak at the banquet on Nov. 3. His subject will be "Engineers' Opportunities in the Field of Fuels." As part of the banquet ceremonies, Ralph A. Sherman, who was nominated as a director at large of the ASME, will be presented the Percy Nicholls Award for 1948. This award, given jointly by the ASME Fuels Division and the AIME Coal Division, honors each year an engineer who has made significant contributions to the field of solid fuels. President Bailey was the first recipient of the award when it was created in 1942.

The tentative program will be published in the October issue of MECHANICAL ENGINEERING.

ECPD Fifteenth Annual Report Available

IF engineering is ever to become in fact a profession, it must first become such in the minds of engineers, according to James W. Parker, past-president ASME, and chairman of the Engineers' Council for Professional Development, whose report for the ECPD year ending September, 1947, is published in the Fifteenth Annual Report of the ECPD.

Included in the 48-page booklet are the annual reports of the ECPD committees on student selection and guidance, engineering schools, professional training, and professional recognition. Each of the reports indicates progress in furthering the ideals of the engineering profession. ECPD is best known for its work in accrediting curricula in the engineering colleges, which is being actively resumed following the disrupted conditions that obtained in the war and immediate postwar period. Investigation of instruction of the technical-institute type wherein no degrees are granted, is a relatively new but much-needed field of ECPD activity. Reflected in the reports is the increased attention being given to selection of the right type of student for the engineering colleges.

Acknowledging the contributions of "field forces" to the success of the ECPD accrediting project, Mr. Parker suggested that the ECPD look increasingly to the engineer at the local level, to his local societies and councils, for aid in the work of co-ordinating and consolidating the profession.

In its report, the Committee on Professional Recognition commented on, among other subjects, salaries of engineers, uniform grades of membership in the engineering societies, and fragmentation of the profession. Engineers in administrative positions should see to it that engineers under their supervision have adequate compensation, the Committee said. The level of engineering salaries will remain low as long as engineers are willing to hire staffs at low salaries.

Uniform grades of membership in the engineering societies was the subject of several meetings during the year. Not only do grades of membership show variations in nomenclature, but also in requirements for similar grades. Some progress was made in the direction of a standard nomenclature but no agreement on grade requirements was reached.

The Committee took note of the danger of fragmentation of the profession introduced by the trend toward specialization which is bringing engineers together in smaller and smaller groups. No study of this problem was made by the Committee.

The ECPD is a conference organized in 1932 to enhance the professional status of the engineer through the co-operative efforts of the following national organizations concerned with the professional, technical, educational, and legislative phases of engineers' lives: American Society of Civil Engineers; American Institute of Mining and Metallurgical Engineers; The American Society of Mechanical Engineers; American Institute of Electrical Engineers; The Engineering Institute of Canada; American Society for Engineering Education; American Institute of Chemical Engineers, and the National Council of State Boards of Engineering Examiners.

Copies of the report may be obtained from the ECPD, 29 West 39th Street, New York 18, N. Y. Price per copy is fifty cents.

Third Annual Conference on Petroleum Mechanical Engineering to Be Held Oct. 3–6, 1948

Headquarters: Herring Hotel, Amarillo, Texas

THE 1948 National Conference on Petroleum Mechanical Engineering sponsored by the Petroleum Division of The American Society of Mechanical Engineers will be held at the Herring Hotel, Amarillo, Texas, Oct. 3–6, 1948.

The conference, which was called a major event of the petroleum industry by local observers in 1947, is expected to attract more than 500 engineers who have responsibility for the mechanical-engineering problems of the industry.

The success of the conferences in 1946 and 1947 was an important factor for the elevation of the Petroleum Committee of the Process Industries Division to professional-division status as the Petroleum Division of the ASME.

To cover administrative and preprint costs, a registration fee will be charged as follows: $3 for members of the ASME and $5 for nonmembers. Registration will entitle delegates to attend all sessions and inspection trips, and to copies of all available preprints of technical papers. At time of registration members are asked to indicate their intention of participating in the various inspection trips and to make reservations for luncheons and the banquet so that arrangements can be made to accommodate all who wish to attend.

Make Reservations Early

For best accommodations members are urged to make hotel reservations as early as possible. These can be made directly through the headquarters hotel or by writing to W. B. Sansing, Amarillo Chamber of Commerce, Amarillo, Texas. For prompt attention from the hotel staff, please indicate in your correspondence that you are a member of the ASME.

The conference will open officially on Monday, Oct. 4, with a luncheon at which the Honorable Lawrence Hagy, mayor of the city of Amarillo, Texas, will welcome the delegates. Pres. E. G. Bailey will respond.

The technical program will consist of 16 sessions at which 33 papers will be presented. The sessions will be sponsored by the following operating committees of the Petroleum Division: Production, Transportation, Refining, Materials, and Manufacturers. A feature of the program will be a symposium on instrumentation in which representatives of oil companies and instrument manufacturers will participate.

Among other subjects to be discussed on the program will be developments in mining of Colorado oil shale, the Union Oil Company's method for recovery of shale oil, problems associated with the Fischer-Tropsch process, synthetic fuel oils, and others.

Members of the Executive Committee of the Petroleum Division are: William Raisch, chairman; E. W. Jacobson, secretary; B. B. Morton; E. N. Kemler; and J. M. Sexton.

The Tentative Program

SUNDAY, OCT. 3

3:00 p.m.

Registration

MONDAY, OCT. 4

8:30 a.m.

Registration

12:00 noon

Conference Luncheon

Welcome Address: Lawrence Hagy, Mayor of Amarillo, Texas

Response: E. G. Bailey, president, ASME

2:00 p.m.

Refining (I)

Symposium on Refinery Instrumentation. *Speakers:* J. A. Pellettere, chief instrument engineer, Gulf Oil Corporation, Pittsburgh, Pa.; T. M. Hoffman, engineering division, Humble Oil and Refining Company, Baytown, Texas; and V. V. Tivy sales manager of refining industry, Foxboro Company, Boston, Mass.

Production Engineering (I)

New Type Dynameter for Well Weighing, by D. O. Johnson, Johnson-Flagg Engineering Company, Tulsa, Okla.

Field Control of Oil-Field Equipment, by James Gregory, division superintendent Shell Oil Company, Inc., Long Beach, Calif.

Manufacturers (I) and Construction Materials (I)

Hydraulic Torque Converters and Fluid Couplings for Oil-Field Machinery, by H. A. Davis, district manager, Twin Disc Clutch Company

Filtration of Fuel and Lubricating Oils Used in Internal-Combustion Engines, by F. Lee Townsend, William W. Nugent and Company, Inc., Chicago, Ill.

Protection of Pressure Vessels by Rupture Discs, by C. E. Huff, firm of Black, Sivals and Bryson, Inc.

Inspection Trip

4:30 p.m.

Stag Party

Buses will take members to 6666 Ranch for an evening of entertainment

TUESDAY, OCT. 5

9:30 a.m.

Refining (II)

Primary Creep in the Design of Internal-Pressure Vessels, by P. R. Shepler, firm of Lessells and Associates, Engineers, Boston, Mass.

Construction Materials (II)

A Survey of World-Wide Corrosion Problems From the Standpoint of Materials, by M. S. Northrup, research metallurgist, Standard Oil Development Company, Elizabeth, N. J.

Notes on the Uses of Stainless Steels in the Petroleum Industry, by Paul Weinman, sales engineer, Armco Steel Corporation, Tulsa, Okla.

Production Engineering (II)

Drilling Rigs for Deep Wells, by J. P. Mahan, director of engineering, National Supply Company, Toledo, Ohio

Drilling Rig Engineering, by W. H. Griffith, chief mechanical engineer, International Derrick and Equipment Company, Columbus, Ohio

2:15 p.m.

Synthetic Liquid Fuels

Synthetic Fuel Plants, by W. C. Schroeder, chief, Office of Synthetic Liquid Fuels, Bureau of Mines, Washington, D. C.

Some Problems Associated With the Fischer-Tropsch Process, by Eugene Ayres, C. W. Montgomery, and Joel H. Hirsch, Gulf Research and Development Company, Pittsburgh, Pa.

Liquid Fuels From Natural Gas, by R. C. Alden and Alfred Clark, research staff, Phillips Petroleum Company, Bartlesville, Okla.

Transportation (I)

Calibration of Positive-Displacement Meters by Volumetric Method, by M. L. Barrett, meter supervisor, Products Pipe Line department, Shell Oil Company, Zionsville, Ind.

Calibration of Positive-Displacement Meters by Gravimetric or Weight Method, by J. B. Smith, Clark Goodman Supply Company, Cleveland, Ohio

Production Engineering (III)

Draw Works Brake Requirements and Characteristics, by R. G. DeLaMater, vice-president, Parkersburg Rig and Reel Company, Parkersburg, W. Va.

Tool Joint Design and Mud Flow in Drilling by S. C. Moore, product engineer, Hughes Tool Company, Houston, Texas

Inspection Trip

7:30 p.m.

Banquet

Presiding: William Raisch, chairman, ASME Petroleum Division

Speakers: E. G. Bailey, president, ASME and Col. Ernest O. Thompson, chairman, Railroad Commission of Texas, Austin, Texas

WEDNESDAY, OCT. 6

9:30 a.m.

Construction Materials (III) and Manufacturers (II)

Results of Tests of Some Pressure Vessels at —320 F, by T. N. Armstrong, metallurgical engineer, International Nickel Company, New York, N. Y.

The Strength of Welded Joints in Thick Aluminum Plates, by C. B. Voldrich, chief welding engineer, Battelle Memorial Institute, Columbus, Ohio

Factors Influencing the Economical Design of Pressure Vessels, by G. E. Fratcher, design and development engineer, vessel division, A. O. Smith Corporation, Milwaukee, Wis.

Transportation (II)

Automatic Control in Diesel and Electric Pipe Line Stations, by S. S. Smith, manager of products, pipe-line department, Shell Oil Company, New York, N. Y.

Crude Oil Gathering Line Design, by F. H. Warren, Ohio Oil Company, Findlay, Ohio

Production Engineering (IV)

Mechanical Controls for High Pressure Oil and Gas Wells, by J. H. Ward, 3rd, senior petroleum engineer, Gulf Coast Division, Humble Oil and Refining Company, Houston, Texas

Automatic Drilling Feed Controls for Rotary Drilling Rigs, by W. S. Crake, chief mechanical engineer, Shell Oil Company, Houston, Texas

Refining (III) and Manufacturers (III)

Construction of Katy Gas Cycling Plant, by W. R. Robertson, design engineer, and N. H. Stamper, assistant chief engineer, Humble Oil and Refining Company, Houston, Texas

Oil-Field Boilers—Performance and Construction, by S. Mensonides, vice-president, oil-field division, Farrar and Trefts, Inc., Buffalo, N. Y.

2:15 p.m.

Transportation (III)

Pressure Surges in Pipe Lines, by E. T. Skinner, student engineer, Oklahoma A&M College, Stillwater, Okla.

Pressure Surges in Pipe Lines, by C. B. Lester, Sohio Pipe Line Company, St. Louis, Mo.

Pressure Surges and Vibration in Reciprocating Pump Piping, by J. W. Squire, Standard Pipe Line Company, Tulsa, Okla.

Production Engineering (V) and Refining (IV)

Mining Colorado Oil Shale, by Tell Ertl, mining engineer, Union Oil Company of California, Rifle, Col.

Development of Union Oil Retorting Method for the Recovery of Shale Oil, by Homer Reed and Clyde Berg, Union Oil Company of California, Los Angeles, Calif.

Construction Materials (IV) and Production Engineering (VI)

Review of Tubular Goods in the Petroleum Industry, by V. V. Kendall, corrosion engineer National Tube Company, Pittsburgh, Pa.

Drill Pipe and Corrosion Problems, by G. L. Corrigan and A. E. Schlemmer, both of Oklahoma A&M College, Stillwater, Okla.

Inspection Trip

1948 Wood Industries Conference Planned for Sheraton Hotel, High Point, N. C., Oct. 14–15, 1948

A SYMPOSIUM of woodworking research laboratories will be one of the features of the 1948 Wood Industries Conference sponsored by the Wood Industries Division of The American Society of Mechanical Engineers to be held at the Sheraton Hotel, High Point, N. C.

The advantages and limitations of the various types of laboratories now doing research in woodworking will be discussed by five experts who will present 12-minute speeches and later form a panel for answering questions from the floor.

Other subjects to be covered during the meeting will be the education program of the wood industries, design of circular saws, a study of the depth of penetration on the withdrawal resistance of nails, and others.

A high light of the social program will be a banquet on Thursday, Oct. 14, at which D. E. Henderson, professor, North Carolina State College, Raleigh, N. C., will speak on "Woodworking Education in the South."

A special program is being planned for the wives of members and guests. This will include a tea on Thursday afternoon, and an inspection trip on Friday afternoon.

For best accommodations, members should write directly to the hotel for reservations. In correspondence with the hotel, members are urged to mention the ASME.

Members of the Executive Committee of the Wood Industries Division are: F. J. Hanrahan, chairman; F. F. Wangaard, secretary; E. D. May, C. R. Nichols, Jr., and R. R. Smith.

The tentative program follows:

THURSDAY, OCT. 14

9:00 a.m.

Registration

9:30 a.m.

Session I

Symposium: Woodworking Research, Advantages and Limitations of Each Type

Forest Products Laboratory, by George M. Hunt, director, U. S. Forest Products Laboratory, Madison, Wis.

University or School Laboratory, by Nelson C. Brown, professor, New York State College of Forestry, Syracuse University, Syracuse, N. Y.

Private Commercial Laboratory, by Armin Elmendorf, president, The Elmendorf Corporation, Chicago, Ill.

Timber Engineering Company Laboratory, by Carl A. Rishell, director of research, Timber Engineering Company, Washington, D. C.

Woodworking Industry Laboratory, by C. D. Dosker, president, Gamble Brothers, Inc., Louisville, Ky.

2:00 p.m.

Session II

An Educational Program for the Woodworking Industry, by L. A. Patronsky, professor school of forestry, University of Michigan, Ann Arbor, Mich.

Fabrication of Structural Members, by F. Powell Forbes, manager, engineering and fabrication division, Weyerhaeuser Timber Company, Newark, N. J.

6:30 p.m.

Banquet

Presiding: F. J. Hanrahan, chairman, Wood Industries Division, ASME, and National Lumber Manufacturers Association, Washington, D. C.

Toastmaster: J. T. Ryan, executive secretary, Southern Furniture Manufacturers Association, High Point, N. C.

Welcome: H. A. Foscue, vice-president, Southern Furniture Manufacturers Association, High Point, N. C.

Speaker: Woodworking Education in the South, by D. E. Henderson, professor, North Carolina State College, Raleigh, N. C.

FRIDAY, OCT. 15

9:30 a.m.

Session III

Two-Species Laminated Beams, by A. G. H. Dietz, associate professor, Massachusetts Institute of Technology, Cambridge, Mass.

Circular Saws—Design, Manufacture, and Operation, by R. D. Brooks, field engineer, E. C. Atkins and Company, Indianapolis, Ind.

Influence of Depth of Penetration on Withdrawal Resistance of Nails, by E. George Stern, director wood research laboratory, Virginia Polytechnic Institute, Blacksburg, Va.

2:00 p.m.

Inspection Trip

Tour through the plant of Tomlinson of High Point, Inc., High Point, N. C.

500 Engineers Attend Idlewild Luncheon

FIVE hundred engineers and executives of the aircraft industry attended the International Air Transport Luncheon held at the New York International (Idlewild) Airport, Aug. 2, 1948, to celebrate the official opening of the airport. The luncheon was a feature of the "Golden Anniversary" International Air Exposition, one of the many events of the jubilee celebrations marking the 50th anniversary of the consolidation of the five boroughs of the City of New York. It was sponsored by the Society of Automotive Engineers with the co-operation of The American Society of Mechanical Engineers, Institute of Aeronautical Sciences, Aircraft Industries Association

of America, and Air Transport Association of America.

Held at the World Flight Club, a large tent in the heart of the exhibition area and a stone's throw from the observation stands before which military aircraft were soon to demonstrate mass flights and precision maneuvers, the luncheon was dominated by a carnival spirit appropriate to the occasion.

While the luncheon was still in progress, H. R. Harris, vice-president of American Overseas Airlines, introduced the toastmaster, Vice-Admiral E. S. Land. Following brief welcome addresses by New York City officials, Admiral Land introduced Sir William P. Hildred, director general, International Air Transport Association, who paid tribute to American vision and enterprise which made Idlewild a reality.

Commenting on the magnitude of airports, Sir William said that only airports which are too large when constructed are economically sound. Idlewild's 10,000-ft runways were not too long and they would never be too short, because in his opinion economic factors influencing aircraft design will discourage construction of planes which require longer runways.

Reviewing the present scale of international air transportation, he said that this year 150 million dollars would be paid for transportation of passengers, goods, and mails over international routes to and from New York and that more than a quarter of a million passengers would move in and out of New York across the North Atlantic route alone.

E. G. Bailey, president ASME, represented the Society at the luncheon.

VDI Resumes Publication of "VDI Zeitschrift"

THE Society of German Engineers (Vereines deutscher Ingenieure) resumed publication of its official journal, *Zeitschift des Vereines deutscher Ingenieure* in March, 1948, according to a letter received by The American Society of Mechanical Engineers from H. Bluhm, president VDI.

The world-famous engineering journal, published since 1856, was discontinued in 1945 when Germany collapsed. Originally a biweekly publication of 100 pages per issue, the last few copies received by the Engineering Societies Library under old exchange arrangements were monthly issues of less than 50 pages.

The first four issues of the new series received from Dr. Bluhm comprise numbers of volume 90. Since the last issues of the old series were numbers of volume 88, it is assumed that volume 89 has been dropped to mark the interruption of three years.

The January, 1948, issue, released in March, has 32 pages. It contains an editorial expressing VDI determination of re-establishing the standing of the German engineering profession. This theme is backed up by the lead article by Waldemar Hellmich on the collapse of the engineering profession in Germany, its past history, and its future. Other articles discuss the nature and significance of the chain reaction of uranium, and the engineering problems involved in the reconstruction of German cities.

ASEE Mechanical Engineering Division Simplifies Structure

THE Mechanical Engineering Division of The American Society for Engineering Education simplified its organizational structure recently by adopting new by-laws which reduce from four to two the working groups of the division. The action, which combines the Heat Power Group with the Mechanical Laboratory Group and the Machine Design Group with the Manufacturing Processes Group, was taken at the 1948 annual meeting of the ASEE, at Austin, Texas, June 14–18, 1948. A desire to simplify administration and to eliminate difficulties of scheduling events prompted the action.

The ASEE Mechanical Engineering Division is composed primarily of mechanical-engineering teachers but many engineers in industry whose responsibilities touch on education also participate. Its activities are aimed at improving training of engineering students to meet the needs of industry. While it approaches problems from the point of view of the teacher, the emphasis is on what to teach and how to improve methods and other related problems of mutual interest to engineers in industry.

The Division publishes two news letters, "Heat Power News and Views," and "Machine Design and Manufacturing Bulletin" which are sent to members. Papers presented at ASEE meetings are published in *The Journal of Engineering Education*, official journal of the society. Among the projects sponsored by the Division have been summer schools for teachers of mechanical engineering.

E. N. Kemler, Mem. ASME, New York University, and H. A. Bolz, Mem. ASME, Purdue University, are chairman and secretary, respectively, of the Division.

Management Division to Conduct Price Survey

A NATION-WIDE industrial survey of high prices, based on increased production and transportation costs, will be undertaken by the distribution committee of the Management Division of The American Society of Mechanical Engineers, it was announced recently by Fenton B. Turck, chairman of the committee, and president of Turck, Hill and Company, New York, N. Y.

Describing the distribution of industrial production as "now America's primary domestic problem," Mr. Turck said his committee would be solely concerned with the assembly of factual material on the subject and invited the co-operation of qualified companies and organizations. The survey is scheduled for completion this year, and will be available on request. It is believed it will be of interest to all manufacturers and consumers.

"The American distribution system is undergoing a radical change almost overnight," Mr. Turck said. "It is confronted with new rules and rapidly increasing costs. These are the most basic economic changes in thirty years. Temporary or permanent, these developments cannot be ignored by manufacturers or consumers. They will directly affect the price of all commodities and manufactured products in small and large cities throughout the country.

"We must face the fact that the indicated changes in the American distribution system concern the stability of employment in the nation's 33 major industrial centers and even the daily diet and standard of living of consumers. Distribution replaces production as the major concern of management."

JOSEPH R. DECKER, NEW MANAGER OF THE ESPS CHICAGO OFFICE

(Mr. Decker succeeds Thomas Wilson, who has retired after 16 years as head of the Chicago office of the Engineering Societies Personnels Services, Inc. During the war Mr. Decker was a lieutenant commander of the U. S. Veterans Administration. For many years he was engineer and sales representative for a large electric-products manufacturer with offices in Chicago and Detroit.)

S. S. Steinberg Continues Good-Will Tour of Latin America

AS a representative of the Engineers Joint Council and The American Society for Engineering Education, S. S. Steinberg, dean, college of engineering, University of Maryland, has been invited by the Department of State to complete the good-will tour of Latin America in the interest of engineering education which he commenced in 1945 when he visited twelve of the other American republics. His present itinerary includes visits to the remaining eight countries: namely, Guatemala, Honduras, El Salvador, and Nicaragua in Central America, Bolivia and Paraguay in the heart of South America, and Dominican Republic and Haiti in the West Indies.

The purpose of the tour is to make a survey of engineering education in the other American republics; promote closer relations between their engineering educators and those of the United States; arrange for exchange of professors; and provide for a wider interchange of engineering and technical publications.

Dean Steinberg left the United States early in August and is expected to return in October.

Actions of the ASME Executive Committee

At a Meeting Held at Headquarters, July 14, 1948

A MEETING of the Executive Committee of the Council was held in the rooms of the Society, July 14, 1948. There were present: E. G. Bailey, chairman, F. S. Blackall, Jr., F. M. Gunby, J. N. Landis, T. E. Purcell; K. W. Jappe, treasurer, F. E. Lyford (Finance Committee); E. J. Kates, A. R. Mumford, Council members; C. E. Davies, secretary, and Ernest Hartford, executive assistant secretary.

Research Projects

Upon recommendation of the Research Committee, a co-operative agreement between The Ohio State University Research Foundation and the Society was approved covering a research project to determine coefficients of discharge of segmental and eccentric orifices in pipes from 3 inches to 12 inches in diameter. Another agreement for sponsored research between the Battelle Memorial Institute and the Society acting jointly with the American Society for Testing Materials was approved covering a project to determine the partition of aluminum between the phases of those plain and low-alloy steels which are susceptible to graphitization.

1948 Honors and Awards

Upon recommendation of the Board of Honors, the following honors and awards were approved:

ASME Medal, Fred. G. Keyes, head of depart ment of chemistry, Massachusetts Institute of Technology, Cambridge, Mass.

Worcester Reed Warner Medal, Edward S. Cole, president, Pitometer Log Corporation, New York, N. Y.

Melville Medal, R. E. Gillmor, vice-president Sperry Corporation, New York, N. Y., for paper on "The World the Manager Lives In."

Junior Award, Hunt Davis, Division Engineer, aerodynamic division, Research and Development Department, Elliott Company, Jeannette, Pa., for his paper "A Method of Correlating Axial-Flow-Compressor Cascade Data."

Pi Tau Sigma Gold Medal, Walter G. Vincenti, Ames Aerodynamic Laboratory, Mountain View, Calif. Honorable Mention, William C. Parrish, General Electric Company, Schenectady, N. Y.

1948 Semi-Annual Meeting

A resolution extending the thanks and appreciation of the Society to the Executive Committee of the Milwaukee Section, local committees, and others who contributed to the success of the 1948 Semi-Annual Meeting, was adopted.

A special resolution of the Meetings Committee, apprising the Council of the excellent way in which the Milwaukee Section, under the leadership of Theodore A. Wetzel, arranged and managed its part of the Semi-Annual Meeting, was noted.

Certificate of Award

A certificate of award commemorating E. A. Uehling's 65-year membership in the Society was confirmed.

Certificates of Award were also approved for the following: J. Mack Tucker, secretary of the East Tennessee Section for the past eight years; A. E. Schell, secretary of the Rochester Section for the past five years; also to the following retiring chairmen: W. Lyle Borst, Minnesota Section, Alfred G. Cattaneo, San Francisco Section, H. R. Kessler, Metropolitan Section, V. A. Peterson, Southern California Section.

Seymour Memorial Fund

It was voted to accept the gift of $5000 from Mrs. James A. Seymour for purpose of establishing the Seymour Memorial Fund to be administered by the "Old Guard" for benefit of members of the society with emphasis on the student and junior members (See page 708 of the August issue of MECHANICAL ENGINEERING for an account of the Seymour Memorial Fund.)

The Library Board

Following discussion of the report of the Special By-Laws Committee of the United Engineering Trustees, suggested structure of the Library Board was approved with the understanding that other member bodies of the UET would take the same action. The Constitution and By-Laws Committee was asked to review the action and to submit changes in the ASME By-Laws that may be necessary.

1948 Gantt Medal

The award of the 1948 Gantt Medal to Fowler McCormick, chairman of the board, International Harvester Company, Chicago, Ill., was noted.

Deaths

The following deaths were noted with regret: Roy V. Wright, past-president and Hon. Mem. ASME, July 9, 1948; Wallace Clark, chairman Organization Committee, Fellow ASME, July 4, 1948; Lawford H. Fry, Warner Medalist, Fellow ASME, July 10, 1948; Mabel C. Smith, member of the staff for twenty-nine years, June 15, 1948.

Appointments

The following appointments were confirmed: Ralph A. Sherman, Engineers Joint Council Committee on Fuel Resources; C. E. Davies, member, E. G. Bailey, alternate, Engineers Joint Council Committee on Unity of Engineering Profession; Col. T. A. Weyher, Osterreichischer Ingenieur und Architekten Verein, Vienna, Austria, Centennial Celebration, June 3 to 7, 1948.

A list of appointments recommended by the Organization Committee to committees and joint activities, was approved.

Resignation

Resignation of J. N. Landis as a member of the Executive Committee of the Council and as a member of the Board on Technology was accepted with regret.

J. N. LANDIS RECEIVES DESK PEN FROM METROPOLITAN SECTION

(*Left to right:* Pres. E. G. Bailey, V. Weaver Smith, Chairman, Metropolitan Section, Mr. Landis, and H. R., Kessler, past-chairman, Metropolitan Section. Mr. Landis resigned from the Executive Committee of the Council because his new duties with the Bechtel Corporation, San Francisco, Calif., made it difficult for him to attend meetings.)

J. N. Landis Honored

ABOUT 30 members of the Metropolitan Section and the Executive Committee of the Council of The American Society of Mechanical Engineers were present at a luncheon at the Engineers' Club, New York, N. Y., on July 14, where J. N. Landis was the guest of honor. Mr. Landis is severing his connections with The Consolidated Edison Company of New York, Inc., and is going to San Francisco, Calif., where he will be employed by the Bechtel Corporation. He has been active in the Metropolitan Section, ASME, for many years and has served on the Executive Committee of the ASME Council.

Presiding at the luncheon was E. G. Bailey, president ASME. V. Weaver Smith, incoming chairman of the Metropolitan Section, introduced H. R. Kessler, chairman during 1948, who commended Mr. Landis on his services to the Section and handed him, on behalf of the Section's officers, a pen set for his desk.

In his response Mr. Landis paid tribute to his fellow workers in the Section and to the value of the personal contacts and friendships which his activities in the Section had won for him. Dean George B. Pegram, who had been chairman of the Section when Mr. Landis' active interest in its work began, reviewed briefly his own connection with the Section and spoke of the satisfaction of "giving yourself away" which such experiences afforded.

Mr. Landis has resigned as a member of the Executive Committee of the ASME Council because his new duties will make it difficult for him to attend monthly meetings.

J. Edgar Kates has been appointed to fill out the unexpired portion of Mr. Landis' term on the Committee.

W. H. McBryde Honored

WARREN H. McBRYDE, past-president and Fellow ASME, was awarded an honorary degree of doctor of laws by the University of Santa Clara, Santa Clara, Calif., on June 19, 1948. Dr. McBryde was honored for his part in "movements looking to individual and community betterment through social, professional, and public-spirited associations."

(*ASME News continued on page 786*)

Engineering Societies Personnel Service, Inc.

These items are from information furnished by the Engineering Societies Personnel Service, Inc., which is under the joint management of the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to members and is operated on a co-operative nonprofit basis. In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient nonprofit personnel service and are available upon request. This also applies to registrants whose notices are placed in these columns. Apply by letter, addressed to the key number indicated, and mail to the New York office. When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available to members of the co-operating societies at a subscription of $3.50 per quarter or $12 per annum, payable in advance.

New York	Chicago	Detroit	San Francisco
8 West 40th St.	84 East Randolph Street	100 Farnsworth Ave.	57 Post Street

MEN AVAILABLE[1]

MECHANICAL ENGINEER, 33, AB, BS, and ME. Ten years' experience in research and development in heat transfer, fluid mechanics, and aircraft power-plant work. Desires business opportunity using engineering background. Speaks French and German. Prefers northern New Jersey; will consider any location. Presently employed. Me-321.

EXECUTIVE, married, Mem. ASME, ASTE, 25 years' experience in tool and die design, planning, methods, process, estimating, general manufacture. Superintendent and factory manager. Location, preferably East. Me-322.

GRADUATE MECHANICAL ENGINEER, 35. Extensive experience in management, maintenance, operations, and sales. Desires position as manager, superintendent, assistant, or sales representative. Able to organize effectively and administer major operations. Me-323.

MECHANICAL ENGINEER, BSME, married, one year's experience in maintenance, design and supervision in chemical-processing industry, seeking permanent position in East with room for advancement. Me-324.

MARINE ENGINEERING, salvage, or construction position desired. BSME West Point, Coast Guard. Diving, marine salvage, design and testing diving equipment experience. ASME, SNAME. Will relocate, travel, foreign. Me-325.

MECHANICAL ENGINEER experienced in the supervision of engineering sales, service, development, and design of machine tools, automatic and special machinery, electrical and pneumatic controls. Willing to travel. Age 36. New England preferred. Me-326.

EXECUTIVE ENGINEER, with 24 years' diversified engineering and administrative experience. Desires position requiring background of Diesel-electric power, instrumentation, mechanical development, and research. Registered in Pennsylvania. Me-327.

MECHANICAL ENGINEER, 32, BSME, 11 years' steam power-plant experience, operating, trouble-shooting, designing, engineering, plant layout, specifications. Will travel or go abroad. Available fall, 1948. Me-328.

MECHANICAL ENGINEER, 22 married. One year's experience in sales department of nationally known general equipment manufacturer. Desires position in sales organization, any industry. Prefers New England. Me-329.

PLANT OR STAFF ENGINEER, BSME, 35, stationary, refrigeration, marine, and professional licenses. Intensely practical. Now employed as assistant to supervising engineer for 23 plants. New York, N. Y., or vicinity. Me-330.

GRADUATE MECHANICAL ENGINEER, registered. 6 years steam-turbine design and manufacture, 2 years gas-turbine development and research. Advanced study in applied mechanics and higher mathematics. Desires responsible position, small company. Me-331.

ADMINISTRATIVE ENGINEER, 48, much experience in processing and manufacturing industries as sugar, textiles, evaporated milk, and tobacco. Can function harmoniously with management. Background includes extensive construction experience, also application modernized process-handling equipment. Me-332.

[1] All men listed hold some form of ASME membership.

POSITIONS AVAILABLE

MATERIALS-HANDLING ENGINEER, 35–45, preferably mechanical graduate who has taken some advanced training in materials handling, methods, techniques and equipment. Should have at least five years' practical materials-handling experience with large manufacturing organization. Salary, commensurate with ability. Location, Massachusetts. Y-1199.

INSTRUCTORS, in heat engineering and mechanical-engineering laboratory or machine design. Position starts Sept., 1948. $2500 depending on experience. Virginia. Y-1200.

GENERAL MANAGER, graduate mechanical engineer, 40–48, with considerable experience, for small-tool company. Should be strong on sales and production. Company does special design work on small tools. Salary, $15,000–$20,000 a year. Location, Middle West. Y-1203-C.

MECHANICAL ENGINEER, preferably with 1 to 3 years' experience in sheet-metal fabrication plant. However, will accept recent graduate interested in this work. Will spend time in shop, drafting room, and do general engineering work. Salary open. New York, N. Y. Y-1206.

INDUSTRIAL ENGINEER familiar with scientific-management installations. Should be a good methods engineer for textile manufacturing. Salary open. New York State. Y-1215.

PLANT ENGINEER, graduate, 40–45, with considerable experience in refrigeration, power, and air conditioning. $7000–$8000. Northern New Jersey. Y-1235.

ASSISTANT OR ASSOCIATE PROFESSOR in heat-power engineering, major field thermodynamics. Interest in one or more of the following: fluid mechanics; heat transfer; gas turbines; and power plants. Master's degree essential. Salary open. Ohio. Y-1253-D.

SALES ENGINEER, 30–50, with 5 to 10 years' experience as mechanical or chemical engineer concerned with design or operation of process-plant equipment, to promote the sale of power-operated process equipment, new, used, and rebuilt. Salary open. Northern New Jersey. Y-1272.

DEVELOPMENT OR ASSISTANT CHIEF ENGINEER for manufacturer of technical steam specialities. Should be imaginative and have good technical background. Excellent opportunity. Connecticut. Y-1288.

ENGINEERS. (*a*) Chief engineer, 45–50, experienced in industrial-plant layout development and the design and supervision of construction of industrial plants. $7500–$7800. (*b*) Industrial engineer experienced in methods and production. (*d*) Mechanical draftsman experienced in industrial-plant layout. Salaries open. Northern New Jersey. Y-1294.

RESEARCH AND DEVELOPMENT ENGINEERS, including research manager, physicist, mechanical, structural, electrical (electronics and communications), utilities, for civil engineering laboratory. $8000–$10,000. Government work. Maryland. Y-1308.

DESIGN ENGINEERS, mechanical degrees required, with experience in aerodynamics or aeronautical design. $8000–$10,000. New York, N. Y. Y-1310.

RESEARCH ENGINEER, young, mechanical. Should have at least a BS degree in ME; MS degree preferred and some experience in research. Work will involve tests on thermal conductivities of new building materials, and studies of various combination wall structures for heat losses. $3600–$3800 a year with one month's vacation with pay. Washington State. Y-1324-R-5110.

JUNIOR MECHANICAL OR INDUSTRIAL ENGINEER with plant experience, to survey and lay out packaging and materials-handling installations. Headquarters, New York, N. Y., with occasional traveling. $3000–$3600. Y-1334.

INDUSTRIAL ENGINEER, 30–35, with metal-products experience, to supervise wage-incentive plan, cost system, in forge plant. $4200–$4800. Connecticut. Y-1336.

JUNIOR ENGINEER, mechanical graduate, 26–30, to make layouts, prepare specifications and

(*ASME News continued on page 788*)

quotations covering process equipment, driers, filters, and conveyers. Must be able to type and handle correspondence. Veteran preferred. \$2400–\$3000. New York metropolitan area. Y-1346.

MECHANICAL ENGINEER, young, preferably with some machine-shop training in addition to technical education for work involving assistance in purchasing, and expediting of shipments. Should be resident of New York, N. Y., or vicinity. Y-1348.

ENGINEER, 30–40, graduate, to supervise mechanical design of light and heavy chemical and food processing equipment. At least 5 years' experience on design of process equipment involving both cast and fabricated construction, required. Salary open depending on experience. Location Western New York. Y-1349.

SALES ENGINEERS, mechanical, with administrative experience and executive ability to become district managers after a short training period. Some experience in sales. Age 38–42. Technical training and mechanical aptitude. \$7000–\$10,000. Headquarters, Indiana. R-5108C.

Candidates for Membership and Transfer in the ASME

THE application of each of the candidates listed below is to be voted on after Aug. 26, 1948, provided no objection thereto is made before that date, and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the secretary of The American Society of Mechanical Engineers immediately.

KEY TO ABBREVIATIONS

Re = Re-election; Rt = Reinstatement; Rt. & T = Reinstatement and Transfer to Member.

NEW APPLICATIONS

For Members, Associate, or Junior

ALLEN, FORREST E., Ames, Iowa
ANDERSON, ALVIN C., Evansville, Ind.
AYER, JOHN LLOYD, Philadelphia, Pa.
BABBITT, CHARLES A., South Gate, Calif.
BARBAZETTE, JOHN H., Hollydale, Calif.
BARBER, HAROLD DALE, Shaker Heights, Ohio
BLANCO, ALFONSO I., Colombia, South America
BRADLEY, FRANCIS T. H., Tripoli, Lebanon
CHAKRAVARTY, BIMALENDU B., Benares, U. P., India
CHEATHAM, JAMES C., Raleigh, N. C. (Rt. & T)
CHIVERS, MICHAEL E., Surrey, England
COPPOLA, SALVATORE E., Brooklyn, N. Y.
CRONK, GEORGE W., East Orange, N. Y. (Rt & T)
CROPPER, JOSEPH CLARENCE, Waterloo, Iowa
CRUSEL, CORNELIUS C., New Orleans, La.
DAVIS, FRANK B., Lakewood, Ohio
DELAMATER, ROBERT G., Parkersburg, W. Va. (Rt & T)
DOBRENEN, CHARLES W., Los Angeles, Calif.
FENNINGER, CHARLES R., San Gabriel, Calif.
FISHER, CHARLES J., Ambler, Pa.
FLAHERTY, WILLIAM JOSEPH, La Canada, Calif.
FRANGQUIST, GUSTAV H., Chicago, Ill. (Rt & T)
FUGLER, RONALD WILLIAM, Quebec, Canada
GARLAND, NEWTON C., Hartford, Conn.
GATY, LEWIS R., Philadelphia, Pa.
GAYTON, OSCAR F., Youngstown, Ohio
GILES, JAMES EDWARD, JR., East Weymouth, Mass.
GOTH, GEJZA J., Sydney, Australia
GRAFF-BAKER, WILLIAM S., London, England
GREEN, PARKER M., Peoria, Ill.
GRISWOLD, ARTHUR S., Bloomfield Hills, Mich.
GUDMESTAD, ALBERT M., Waukegan, Ill.
HAMILTON, JAMES C., Bell, Calif.
HARDING, GEORGE ROLAND, East Pittsburgh, Pa.
HARRIS, BERNICE, New York, N. Y.
HASTY, CHARLES CLEVELAND, JR., San Diego, Calif.
HECK, RICHARD C., Wilmington, Del.
HEINZE, ROBERT KELLOGG, Los Angeles, Calif.
HESSE, NORBERT F., Alhambra, Calif.
HILDEBRAND, WILLIAM CHARLES, JR., New Orleans, La.
HILL, VERNON R., Richland, Wash.
HOLDER, JAMES F., Birmingham, Ala.
HOPKINS, GEORGE W., San Leandro, Calif. (Rt & T)
HUNTER, NORMAN WALLACE, JR., Portland, Ore.
IMPERIAL, ANDREW A., Richmond, Ind.
JACOBI, ALFRED J., Bronx, N. Y.
JANSEN, RICHARD M., Topanga, Calif.
JOHNSON, CLEMENT O., Savannah, Ga.
KAFADAR, AHMED D., Evanston, Ill.
KNECHT, JOHN E., New York, N. Y.
LAMM, MORTON, Philadelphia, Pa.
LARSON, CEDRIC GARETH, Berkeley, Calif.
LEMKE, EDWARD L., Clifton, N. J.
LIEBERMAN, ARTHUR, Bronx, N. Y.
LONGON, ALCESTE E., New York, N. Y.
LURE, JOHN S., Oak Ridge, Tenn.
MALSTROM, LEONARD P., Chicago, Ill.
MARQUIS, ROBERT I., Alhambra, Calif.
MATSON, FREDERICK W., Crawfordsville, Ind.
MAYER, RICHARD L., Los Angeles, Calif. (Rt & T)
MC CONNOR, WILLIAM SANDBORN, Toledo, Ohio
MC WILLIAMS, ROBERT W., Huntington, W. Va.
MENDELSOHN, MAX, Boston, Mass. (Rt & T)
MICHELETTI, GIAN FEDERICO, Torino, Italy
MILES, HUGH SMITH, JR., Blacksburg, Va. (Rt)
MILLER, STANLEY J., Chicago, Ill.
MORETTI, CHARLES D., Pittsburgh, Pa.
MORGAN, W. RALPH, Atlanta, Ga.
MORTON, ALBERT S., Huntington, W. Va.
NASH, WILLIAM A., Ann Arbor, Mich.
NEGULESCU-OLT, DUMITRU, Addis Abeba, Ethiopia
O'HALLORAN, JAMES, Quebec, Canada
OSGOOD, WILLIAM R., Washington, D. C. (Rt & T)
PARTRIDGE, EVERETT P., Pittsburgh, Pa.
PELLETTERE, JOSEPH A., Pittsburgh, Pa.
PETERSON, CARL W., North Hollywood, Calif.
POLLARD, TERENCE A., Dallas, Tex. (Rt & T)
POLONSKY, BERNARD, Worcester, Mass.
PREUSS, HOWARD M., Oak Ridge, Tenn.
PRICE, HARRY ARTHUR, Los Angeles, Calif.
ROSSMOORE, HOWARD, Manhasset, N. Y.
SANNES, WILLIS C., Maywood, Ill.
SANT, JOHN W., New Castle, Pa.
SCHOFIELD, JOHN CHRISTIAN, Burbank, Calif.
SCHROEDER, CHARLES S., Jenkintown, Pa.
SEN GUPTA, SUDHIR RANJAN, Howrah, Bengal
SNEED, CARL MILLER, JR., Columbia, Mo.
STEELE, RALPH W., New York, N. Y.
STEPHENS, FOSTER MERRILL, Los Angeles, Calif.
STEVENS, HAROLD P., Bellflower, Calif.
SWAN, HUGO, Rochester, N. Y.
SWANSON, CLARENCE FLOYD, Garden City, N. Y.
TADEWALD, RICHARD H., Los Angeles, Calif.
THORNBURG, ALVAN Z., Whittier, Calif.
TRAIN, JAMES STARK, Melbourne, Australia
WALTMAN, EARL R., Louisville, Ky.
WARD, EDWARD D., Birmingham, England
WARREN, JOHN E., Newark, N. J.
WEIHOFEN, GERALD J., Chicago, Ill.
ZELISKO, STEVE, Chicago, Ill.

CHANGE IN GRADING

Transfer to Fellow

BRILLHART, SAMUEL E., Lutherville, Md.
WOODS, BALDWIN M., Berkeley, Calif.

Transfer to Member

ALLEN, ROBERT K., Waldwick, N. J.
BENSON, STUART WELLS, JR., Pittsburgh, Pa.
BOLSTAD, MILO MYRUM, Columbia, Mo.
ERSTED, GORDON T., Minneapolis, Minn.
FABIAN, FRANCIS GORDON, JR., Melrose Park, Ill.
FASSBENDER, WALTER J., Philadelphia, Pa.
HIBBELER, GIETNER L., St. Louis, Mo.
KEMPE, WALTER F., Salt Lake City, Utah
KERR, JOHN RUSSELL, Huntington Park, Calif.
KIERNAN, BERNARD LACOSTE, JR., New Orleans, La.
LACHMAN, LOUIS A., New London, Conn.
LEISENHEIMER, ROBERT H., Cleveland, Ohio
MATHEZ, EDMOND C., Rutherford, N. J.
MATHIS, HAROLD F., Evanston, Ill.
ROSS, CHANDLER C., West Covina, Calif.
THRALL, EDWARD WOLFF, JR., Los Angeles, Calif.
WILCOX, ABBOTT DAVIS, Milford, Conn.
WOLFE, CHARLES H., Detroit, Mich.
YEAGER, BRUNO J., Cincinnati, Ohio

Transfers from Student Member to Junior......200

Necrology

THE deaths of the following members have recently been reported to headquarters:

AUSTIN, WILLIAM SUMNER, date not known
CLARK, WALLACE, July 4, 1948
DALBY, VERNON L., date not known
FRY, LAWFORD H., July 10, 1948
HEATH, ROYAL V., JR., June 12, 1948
JACKSON, LAWRENCE BAILEY, July 4, 1948
PORSKIEVIES, ANTHONY JOSEPH, July 3, 1948
ROBBINS, WILLIAM FRANCIS, June 13, 1948
SHIMER, ABRAHAM A., July 10, 1948
THOMAS, HORACE TUCKER, date not known
TILTON, HENRY BENSON, date not known
WALMSLEY, GEORGE, July 16, 1948

• Keep Informed . . .

Announcements in this section are about
current advertisers in MECHANICAL ENGINEERING
and A.S.M.E. MECHANICAL CATALOG.

All items are supplied by these advertisers
and the section is restricted to them.

• NEW EQUIPMENT
• BUSINESS CHANGES
• LATEST CATALOGS

Available literature or information may be secured by writing direct to the manufacturer and mentioning MECHANICAL ENGINEERING as a source.

• *NEW EQUIPMENT*

G-E Sintered Alnico Permanent Magnets

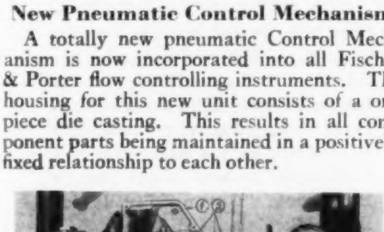
Pittsfield, Mass.—Use of two General Electric sintered alnico permanent magnets separated by an aluminum diaphragm now provide a leak-proof magnetic coupling for an improved liquid level gage made by The Boston Auto Gage Co. here. The magnets are made of G-E alnico 2.

Designed to indicate accurately the level of the insulating liquid in the transformer, the gage utilizes a float inside the transformer tank to transmit the motion of the liquid to one of the alnico magnets. This magnet in turn transfers its motion by a powerful magnetic flux to a similar magnet placed on the other side of an aluminum diaphragm and attached to a dial indicator needle.

The aluminum diaphragm is pressure tight to a minimum of 30 pounds per sq. inch effecting a permanent seal between the liquid and the gage proper. To effect a seal in the opening where the gage is installed, the gage flange is mounted with four studs to the side of the tank, usually below the maximum oil level and is then sealed by a hy-car gasket.

New Pneumatic Control Mechanism

A totally new pneumatic Control Mechanism is now incorporated into all Fischer & Porter flow controlling instruments. The housing for this new unit consists of a one piece die casting. This results in all component parts being maintained in a positively fixed relationship to each other.



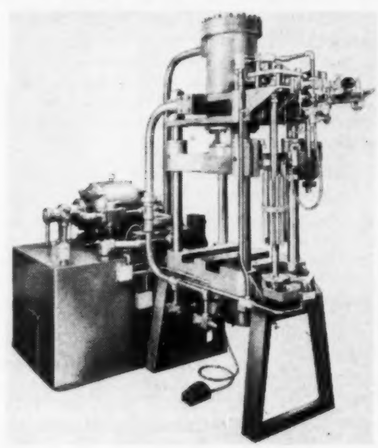
All important working parts are made from precision castings or heavy stampings, precision trimmed and carefully inspected to assure complete interchangeability.

The entire assembly may be removed from the control instrument for cleaning or repair without disturbing the process, by simply flicking the transfer valve to the "Service" position, disconnecting a single air line and removing four screws.

A minimum of tubing connections eliminates air leakage troubles. Absolute alignment of pen and index is certain throughout the range since both index and input links swing on a common center. Valve action is easily reversible without altering link relationships. The pen faithfully tracks the set point throughout the 0 to 200% throttling range adjustment.

Reset is calibrated accurately from 0.2 to 50 minutes, guaranteeing "on the beam" results the moment the controller goes on stream. Write Fischer & Porter Co., Dept 7A-N, Hatboro, Pa. for a copy of Bulletin 50.

New Tube-Bending Press Doubles the Number of Bending Sequences



A new hydraulic tube-bending press having an unusually large number of bending combinations has been announced by Elmes Engineering Works. Unlike previous 12-position presses that actually could be set up for only 6 different bending sequences, this new Elmes press allows any number of sequences up to the maximum of twelve, with adjustable bending depth and automatic reset. This feature, together with a choice of four bending radii, gives users a selection of any or all of forty-eight possible bending variations for forming exhaust pipes, frames, furniture tubing, and similar products on a mass production basis. Press capacity is 20 tons.

Convenience, accuracy, and speed are claimed for this latest Elmes development. The press bed has two cushions. In line with each cushion are two bending noses, each having a different radius. An entirely new indexing device, said to be a major improvement in bending-press operation, controls the sequence and depth of bends. After sequence has been completed, the index automatically resets to starting position. Foot treadle control operates the press cycle, leaving operator's hands free to handle tubes.

This new Elmes press is said to offer generous flexibility of use. Different bending combinations can be set up quickly and easily, making it feasible to use the press for experimental runs as well as production. Uniformity of work is claimed at any production speed, because all bends are controlled mechanically. For more information about this new hydraulic bending press, write Elmes Engineering Works of American Steel Foundries, 239 North Morgan St., Chicago, Illinois.

New Model 21 BW Whiteprinter Is Announced by Bruning

Important features and advantages usually found only in much higher priced machines are embodied in the new Bruning Model 21 BW Whiteprinter, according to Charles Bruning Co. officials. Intended for moderate volume print production, the new BW Whiteprinter is moderately priced, yet utilizes the complete range of Bruning BW media when reproducing engineering drawings in ink or pencil and printed or typewritten office forms from translucent or transparent original material.

Continuous in operation, the Model 21 exposes and develops cut sheets or roll stock up to 42 inches in width—any length. Printing speed ranges from 6" to 4' per minute depending on the transparency of the original. The machine can produce more than three thousand $8\text{-}^1/_2$ x 11 BW Whiteprints per day. Only one operator is needed. Like all Bruning Whiteprinters, the Model 21 requires no plumbing connections or exhaust ducts—can be installed anywhere in plant or office where electric outlets are available.

One of the new and outstanding features of the Model 21 is its built-in constant voltage transformer. Bruning officials say that this

Continued on Page 42

• Keep Informed

is the first time that such equipment has been installed as standard in models of this type.

The compact design of the Model 21 permits an exceptionally large and ample feedboard. Feeding of the BW sensitized cut sheets and the original copy into the printer section is simple and direct. After exposure, the original and exposed BW medium are returned to the operator in the receiving tray. The exposed BW medium is then fed into the developing unit, from which it emerges as a finished BW Whiteprint.

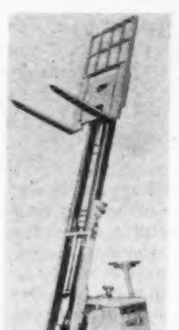
Controls of the Model 21 are few and simple, making it easy even for an inexperienced person to become an efficient operator in a short time. The light source for exposure is a stationary 1,200 watt glass mercury arc lamp, mounted within a cylinder having sufficient length to provide ample and uniform distribution of light over the entire exposure area. The built-in constant voltage transformer assures longer lamp life and enables the lamp to operate at its optimum rating, regardless of line voltage changes, within a 30-volt range.

The developing unit of the Model 21 employs a new principle of developing—grooved dual application developer rolls, which, with the aid of a third roll, apply a minute film of BW developer solution to both sides of the BW medium simultaneously, thus assuring proper chemical balance of the developer solution and flat, ready-to-use BW Whiteprints—positive copies of the original. Developing speed is 10 feet per minute, far enough in excess of the speed of the printing unit to enable the operator to co-ordinate the exposing and developing of all BW mediums.

The Model 21 exposes and develops regular BW papers—light, medium or cardweight, on which can be developed black, blue, red or brown lines on white backgrounds. Green, pink or yellow tinted BW papers can also be exposed, on which can be developed black, blue, red or brown lines. BW transparent paper, BW cloth and BW matte film are all exactly and quickly exposed and developed on the Model 21.

Yale Announces New 120-Inch Telescopic Worksaver

A new 120-inch telescopic Worksaver has recently been announced by the Materials Handling Division of The Yale & Towne Mfg. Co. The new tilting fork model—the highest-lifting "walkie" available—has a capacity of 3000 lb and was specially designed to make possible maximum use of available headroom in high-stacking operations. The high reach feature—a full ten feet—can also be used profitably: (1) in reaching such high levels as mezzanines, (2) in servicing overhead cables and ducting, and (3) in loading airplanes, street trucks, and rail cars from the ground level.



Such an unusually high reach (120″) combined with such a low lowered clearance (83″) is accomplished by means of a ram-within-a-ram. When an outer hydraulic piston has fully extended upward, an inner one begins to extend downward, doubling the lift available.

The truck travels at 2 miles per hour under full load, lifts 8 ft per minute with 2500 lb load, and tilts a full 18 degrees in 10 seconds. Total weight of the truck, including a 19-

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plate battery, is 3,640 lb. Though battery powered in every respect, it is guided by a walking operator.

Worksaver dimensions—33 inches wide by 64 inches long—make it desirable where aisle space is narrow, when freight cars or street trucks must be entered for loading purposes, and in riding elevators.

The 83-inch telescoped-mast-height permits the truck to operate under low headroom conditions which prohibit use of high-mast trucks. Such conditions exist where there are low doorways, low overhead conduits and service equipment, and where the bodies of public carriers must be entered for loading and unloading.

Applications of the new truck will be found in warehouses, freight depots, food processing plants, paper mills, bottling plants, chemical plants, soap factories—in short over the whole range of industry where overhead space is available for storing materials, where goods must be moved from one location to another, and where high levels must be reached.

Closed Condensate Drainage System Increases Efficiency and Saves Fuel

Rapid adaptation of the closed condensate return system over the past ten years has resulted in impressive production and quality of product improvements, increased boiler capacitites, and tremendous fuel savings.

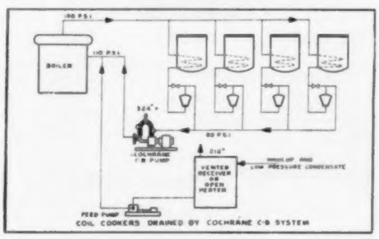

Fig. 1. Here the Cochrane C-B High Pressure Condensate return system is applied to four coil cookers, simply bypassing the older less efficient open system.

Open systems, in general, do not provide complete and rapid removal of condensate from steam-consuming equipment. The equally important problem of ridding the equipment of accumulated air and non-condensable gases is not efficiently accomplished. In all types of steam cooking, heating and drying processes, particularly in batch operations and always on start-up, the accumulated air is a major problem to efficient operation. In one paper mill, the operator claims that start-up is now possible in 10 or 15 minutes with a closed system as against 2 to 3 hours previously (Norristown Magnesia & Asbestos Co., Norristown, Pa.).

The accompanying plant layout shows the conversion of a typical open system—through equipment to a vented receiver from which the cooled condensate is fed back to the boiler—to a closed system. In the closed system the 100 psi boiler pressure drops only to 80 psi at the outlet of the cooking coils shown here and the condensate at the temperature corresponding to this pressure (320°F), after having been purged of entrained air, is immediately returned directly to the boiler. Flash loss is completely eliminated; boiler feedwater temperature is increased 114°F. A company drying spent brewery grain for high-vitamin stock feed (Capland Grain Co., Baltimore, Md.) has increased feedwater temperatures 150°F and eliminated 75% of previous makeup water.

However, the major advantage of closing a currently open system of condensate drainage in most cases is increased production. The prompt and positive removal of condensate and accumulated air from steam cooking and drying equipment results in hotter ket-

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tles, presses, coils, and drums. This is due to the maintenance of high steam velocity within the equipment which permits turbulent flow of the hot steam and reduces to minimum values the thicknesses of insulating air and condensate films as shown on the right of the accompanying drawing. In normal slow-moving laminar flow, as shown on the left of the drawing, temperatures are considerably reduced at the heating surface, just the point at which the heat is utilized. The result of this turbulent flow is to raise surface temperature which results in faster production with higher quality product. A candy manufacturer (Minter Bros., Philadelphia, Pa.) cut candy cooking time 50% with a "whiter" cream due to faster cooking; marmalade cooking has been reduced from 20 minutes to 12 minutes per batch (Colonial Preserves, Buffalo, N.Y.); laundry pressing time has been reduced up to 70% (Morgans Laundry, St. Louis, Mo.); and textile drying capacity has been increased 15% to 25% (Rhode Island Worsted Co., Stafford Springs, Conn.) A corrugated paper manufacurer reports less spoilage from poorly glued sheets (Birmingham Paper Co., Birmingham, Ala.) and a tobacco processor (Taylor Bros., Winston-Salem, N. C) states that his major benefit has been improved tobacco flavor due to more uniform drying.

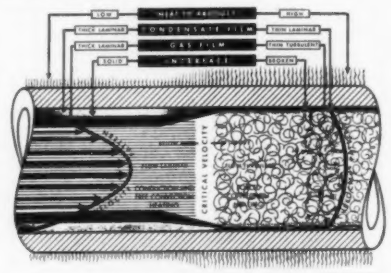

Fig. 2. Graphic representation of the increased heat transfer ratio of high-velocity turbulent flow as maintained by the Cochrane C-B System (right) compared with the inefficient laminar steam flow typical with open system operation.

A dividend paying attribute of the closed condensate circuit, of utmost importance to efficient plant operation as fuel and transportation costs continue to rise, is the resultant fuel savings. A large laundry (Brunswick Laundry, Jersey City, N. J.) has reported $6000.00 annual fuel savings and a manufacturer of mechanical rubber goods (Schacht Rubber Manufacturing Co., Huntington, Ind.) claims fuel savings greatly exceeding 25%. A felt manufacturer burns 3 instead of 4 carloads of coal a month—25% saving (Denson Felt & Hair Co., Philadelphia, Pa.) and a textile dyer with a previously overloaded boiler plant (Reading Dyeing Co. Reading, Pa.) has been able to shut down a 125-hp boiler.

For further information on the design, principle of operation, and typical operating advantages write Cochrane Corp., 3142 North 17th Street, Philadelphia 32, Pa., for a copy of Publ. 3250 describing the Cochrane C-B High pressure Condensate Return System.

Westinghouse Wound-Rotor Life-Line Induction Motor

A new wound-rotor Life-Line induction motor of open drip-proof construction is available from Westinghouse Electric Corp. in ratings of 1 to 15 hp (Frames 203 through 326). The frame is rolled from steel plate and the feet are pressed steel. The pulley end bracket is pressed steel and the front end bracket is close-grained gray cast iron.

The brushes for this motor—Type CWP—are made of electro-graphite or metal graphite depending on service requirements. Brush-holders are of the sliding box type with adjust-

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able spring tension. They are mounted on steel bolts with Micarta spacers. The collector rings are molded solidly into Moldarta insulation bushing that is pressed on the shaft.

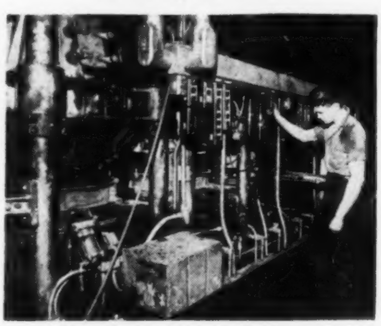
Rotor core consists of punchings riveted into a solid structure and held on the shaft by a shrink fit. Rotor windings have coils threaded into partially enclosed slots. An oversize fan gives maximum air circulation. Self-sealed, pre-lubricated ball bearings have a special lubricant sealed-in at the factory. Under normal conditions further lubrication will not be necessary for five years or longer.

The Type CWP wound-rotor motors may be used wherever adjustable speed is required, or where high-starting torque with low-starting current is necessary. Their balanced design and rugged construction make them especially useful for driving compressors, plunger pumps, positive pressure blowers, or for bringing heavy loads up to speed. Their quiet operation makes them especially suitable for adjustable speed ventilating fan drives.

The motors are available for 60, 50 and 25 cycle, two and three phase, 208, 220, 440 and 550 volts; 1750, 1160, 870, 690, 580 rpm for 60 cycle, 1450, 965, 715, 580, 485 for 50 cycle, 1450, 750, 485 for 25 cycle; 40° C rise, continuous open-constant speed. Type P base for vertical mounting and several types of flanges or brackets are available for horizontal mounting.

Further information about this Type CWP wound-rotor Life-Line induction motor may be obtained from Westinghouse Electric Corp., P. O. Box 868, Pittsburgh 30, Pa.

Completely Automatic Molding Machine



A self-contained molding machine performing all the functions and operations to produce molds from introduction of the sand ingredients through completion of multiple molds stacked six high ready for pouring is now in operation at the Cleveland, Ohio, plant of the Westinghouse Electric Corp. Developed through the joint efforts of International Molding Machine Co., Lagrange Park, Ill.; Westinghouse and other cooperat-

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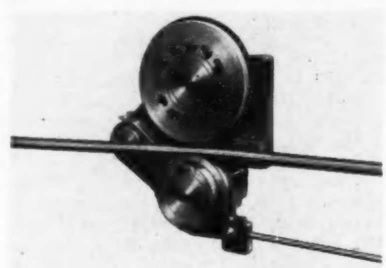
ing companies; the new machine is increasing the yield of high-quality castings at reduced cost and is believed to be the first completely automatic molding unit for mass production of castings by multiple molding methods.

All equipment is arranged in a synchronized operating sequence actuated by air and hydraulic power under complete electrical timing and control. There are four principal work positions in the molding unit. Sand is blown into a flask at the first position to make a preform of the mold. In the second position, the sand in the flask is squeezed around a drag pattern in the bottom of the flask under pressure of 50 tons by a head carrying a cope pattern. The drag pattern is removed in the third position and flasks are stacked six high in the fourth position to make up five complete molds in each stack.

Completed stacks then travel on a conveyer system by the pouring platform and cool as they continue around the back side of the machine. The flasks are shaken out in a machine near the first work position where they are available to start the circuit again.

Acromark Develops New Friction Type Rod and Wire Marking Unit

Marking, at the speed of production on steel, iron, brass, lead and plastic rod, tubes or cable can now be accomplished with a new unit developed by The Acromark Co., Elizabeth, N. J., it is claimed by the manufacturer.



This marking unit is designated as Marking Machine No. 14. It consists of a ball bearing marking roll that carries engraved steel segment dies that are held in position by means of a face plate with flange that fits into channels of segment dies. Screw holes are elongated to permit changing of segment dies by simple loosening of the screws and a slight turn of the face plate.

This marking roll is mounted on an angle type of base which can in turn be bolted to a bench or stand. At one end of the base is a pivoted arm also bearing mounted and on the end of the arm a ball bearing grooved pulley is mounted. This pulley is interchangeable for different size grooves to suit the various diameters of rod, tube or wire.

A projection beneath the base carries an eccentric adjustment operated by a hand lever to provide the adjustment for diameter of rod or tube and for depth of marking.

In operation the free rotation of both the marking roll and the grooved pulley permits the rod, tube or cable to be fed through at any speed and the continuous engraving on the marking roll causes constant rotation and resultant continuous marking.

Strongly built, this unit is suitable for applying the pressure necessary for marking materials ranging from soft plastics to tool steel and continuous use in rod mills, lead-jacketed cable plants and plastic insulated cable plants has proven the practicability of the unit. Further details will be gladly furnished upon application to the Acromark Co., 345 Morrell St., Elizabeth 4, N. J.

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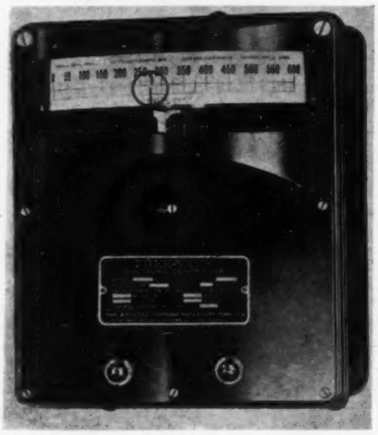
Bristol Develops Proportioning Pyrometer Controller



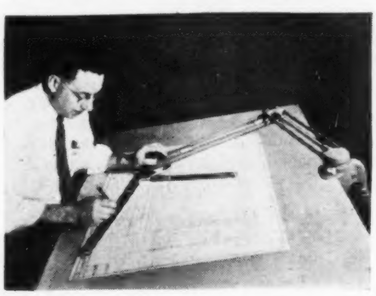
The development of a proportional current-input electronic pyrometer controller has been announced by The Bristol Co., Waterbury 91, Conn. The new instrument proportions the current input to electrically-heated furnaces, ovens, plastic molding machines, salt pots, and other similar equipment to provide practically straight-line temperature control. It does this by time modulation of the input energy. The average energy supplied is proportional to the deviation of the temperature from the control point throughout a band width, which is adjustable from 0 to $2^1/_2$ percent of full scale reading.

The instrument, Model IE486, is described in Bulletin PB1237 which can be obtained from The Bristol Co., 112 Bristol Road, Waterbury 91, Conn.

New Features Added to Bruning Drafting Machines

The Charles Bruning Co., 4754 Montrose Ave., Chicago 41, Ill., has recently announced the addition of new and modern features in their Standard and Civil Engineer's Drafting Machines. Unusual smoothness, greater accuracy and unhampered speed in drafting is achieved through new features built into the modern Bruning Standard "Equipoise" and Civil Engineer's "Equipoise" Drafting Machines.

The most outstanding of these new features is the new, unique "Equipoise" mechanism, that insures accurate alignment at all times on an inclined drawing board. Even though the board may be inclined as much as 20° from horizontal position, the "Equipoise" mechanism maintains accurate alignment.



Other new features include a revised protractor head assembly, permitting greater convenience in drafter operation—with maximum visibility—a relocated and redesigned base line setting device for locking the protractor index point to any angle, is

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simple in operation and positive in action—to further increase the efficiency of the positive-grip, double clamp; distance between clamp screws has been increased, holding drafter securely and rigidly to drawing board.

Designed and built as a precision instrument, the Bruning Standard "Equipoise" Drafting Machine with the popular "Touch Control" feature is ideal for use by mechanical, architectural and structural draftsmen, saving, in many instances, ten to twenty percent of a draftsman's time.

The Bruning Civil Engineer's "Equipoise" Drafting Machine is especially designed for the use of map plotting draftsmen and navigators. It provides a quick, accurate method of plotting maps directly from the surveyor's notes. This machine is also ideal for use by municipal and utility engineers, geologists, and workers in allied fields.

New features have also been added to the Bruning Detail Drafter. This drafter, though small in size has been designed, engineered and produced with the same craftsmanship and high standards of quality that are characteristic of the larger Bruning Standard and Civil Engineer's "Equipoise" Drafting Machines.

These Drafters combine, in a compact precision instrument—"T" square, Straight edge, Triangle, Protractor and Scales.

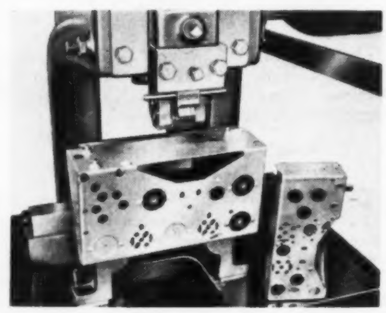
New Motor Capacitor Announced by G. E.

A new Pyranol motor capacitor, designed to withstand the same physical treatment as the motor itself, has been announced by the Transformer and Allied Products Divisions of the General Electric Co. Available from stock in all popular ratings, the new capacitor is completely enclosed in 10-gage steel tubing.

Bushings are of silicone, the new rubber-like material that seals permanently by compression without gaskets or stickers, and that is impervious to oils, acids, and alkalies. The steel mounting bracket is spot-welded to the capacitor enclosure.

Long Flamenol leads are protected by insulating eyelets where they pass through the enclosure, and are unaffected by baking heat, oil, water, or mild acids.

New Acromark Press Fixture Facilitates the Numbering of Metal Stampings



A new adjustable stamping fixture adaptable for use in any standard press is announced by The Acromark Co. The fixture is a casting on which is mounted adjustable steel slide blocks that permit the stamped part to be numbered on the end and again on the side in two successive press strokes. To accomplish duplicate numbering, a duplicating fixture for operating the actuating arm of the numbering head is added. Adjustment of the stamping fixture is readily made by the loosening of the screws and the fixture as illustrated will hold stamped parts having one or more flat surfaces ranging from 1" x 2" to 4" x 10".

Particularly adaptable to use in the numbering of instrument and radio chassis, this fixture is available for delivery in ten days, but in special sizes, three weeks. The Acromark Co., 345 Morrell St., Elizabeth 4, N.J.

New High-Low Signals for Water-Level Indication

To extend the use of its Remote Liquid Level Indicator, the Yarnall-Waring Co. has developed a new attachment for operation of one or more distantly located electric type visible or audible high-low alarm signals and/or controllers for pump motors or other devices in steam power stations and industrial plants. As shown in cut, the new control unit is attached directly to the Yarway Indicator, which is operated by the boiler water

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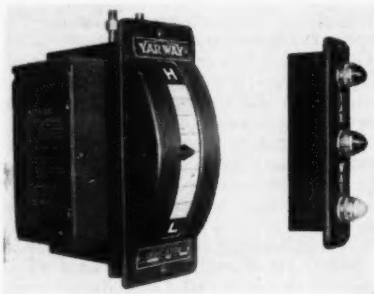
itself and registers all variations of the level in boilers, feed water heaters and other storage vessels.



The control unit consists of simple two-pôle curved-bar permanent magnet fixed to shaft of indicator pointer and actuating one or the other of two sealed-in glass mercury switches which in turn operate the hi-lo alarm signals installed at remote locations where additional check on the liquid level may be required. The visible signal (illustrated) shows red light at top or bottom for high level or low level condition corresponding to high-low positions of indicator pointer; center lense shows green or amber during normal level range of indicator. Audible hi-lo signal uses two vibrating horns of different tones or a single horn for both high and low levels.

Bulletin WG-1822 gives complete information on indicator, control unit and remote signals. Write to Yarnall-Waring Co., Chestnut Hill, Philadelphia 18, Pa.

New 150 lb. Bronze Gate Valves Feature Interchangeability

A new line of 150 lb. S. P. Bronze Gate Valves has been announced by the Lunkenheimer Co., Cincinnati, Ohio. Designed to meet specific needs and preferences of valve users, the new valves are made in three types: Fig. 2150, where the flexibility of the double disc valve is desired; Fig. 2151, for use where the solid disc is an advantage, as in food processing plants and handling gummy substances; and Fig. 2153, a non-rising stem type for use where head room is restricted.

All of the valves are equipped with the exclusive Lunkenheimer patented alloy stems. This stem material has shown remarkable resistance to wear, both in tests and field use, according to the manufacture, and minimizes stem thread failures.

The three types of valves in the new line are largely interchangeable. The same body is used in Figs. 2150, 2151 and 2153, requiring only an interchange of trimmings to convert from one type to another. Screw and valves

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are rated at 150 lbs. S. P.—300 lb. W. O. G.; flange end valves at 150 lb. S.P.—225 lb. W. O. G.

Among the features claimed for the new valves are: a deep stuffing box with extra long threads and a hexagon head gland to permit use of wrench; fully machined repacking seats so that the valve may be repacked under pressure; heavy body and bonnet; and "stay-on" discs which cannot fall off the stem.

A descriptive folder presenting this new line of 150 lb. S. P. Bronze Gate Valves is available. Send for your copy.

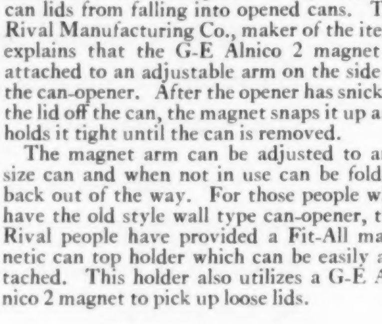
G-E Magnet Keeps Fingers Out of Soup

Pittsfield Mass.—There's a new G-E magnet to keep your fingers out of the soup. That is if your soup comes in cans.

Fishing for loose can lids is now a thing of the past, for a new wall type can-opener known as Can-O-Mat incorporates a General Electric Alnico 2 magnet to keep loosened can lids from falling into opened cans. The Rival Manufacturing Co., maker of the item, explains that the G-E Alnico 2 magnet is attached to an adjustable arm on the side of the can-opener. After the opener has snicked the lid off the can, the magnet snaps it up and holds it tight until the can is removed.

The magnet arm can be adjusted to any size can and when not in use can be folded back out of the way. For those people who have the old style wall type can-opener, the Rival people have provided a Fit-All magnetic can top holder which can be easily attached. This holder also utilizes a G-E Alnico 2 magnet to pick up loose lids.

G. E. Announces Sintered Alnico 5



General Electric announced recently that its Metallurgy Division has perfected a method of sintering Alnico 5, a permanent magnet material which permits the design of intricate shapes with higher external energy than has been heretofore possible. The material is especially adaptable where small powerful magnets having high magnetic properties are required and is expected to find extensive use in the electronic, electrical, instrument, and novelty industries.

G. E. stated that the sintering process permits the ecomical production of small sized parts which are finer grained, less brittle. The material has unusually high tensile properties and can be produced with smooth surfaces and close dimensional tolerances. The fine structure of the G-E material also is said to eliminate crystal pick-outs and pitting.

Sintered Alnico 5 has a residual induction of 10,000 gauss and a coercive force of 575 oersteds. Its guaranteed available minimum energy is 3,500,000 gauss-oersteds for most sizes and shapes. These properties apply only in the direction of heat treatment.

The new sintered material is now being used in relays, meters, fountain pens, electronic reproducers and compasses.

Vibratory Vertical Bowl Feeders

A unique method of applying electromagnetic vibration to a bowl container produces a circular traveling and climbing motion of small pieces, parts, or bulk powders etc.

By having a grooved track ramp up the inside of the wall of the bowl these small pieces can be fed one at a time, in single file, in a predetermined manner to a machine, to packages, for inspection, for counting, for assemblying to other parts and to similar purposes. The illustrations show how small parts can be fed, one at a time, fast or slow.

Speed of feed and starting and stopping of flow can be readily controlled.

The size of the piece to be handled, particularly the length, determines the arc of the grooved track, consequently, the size of the bowl.

Used as a feeder machine for powders, etc., it will feed down to extremely small quantities and stream size, furnishing its own agitated and vibrated bowl supply hopper.

Can be operated from 110, 220 or 440 volt, A. C. Current.

Detailed information is available from Syntron Co., 498 Lexington Ave., Homer City, Pa.

Instrument Manufacturer Recruits Large Training Class

Bailey Meter Co., Cleveland, Ohio, inaugurated its 1948 Cadet Engineering Class on July 6. A large group of engineers reported, including several from Canada and one from England. The class, one of the largest in Bailey Meter Company's history, is necessitated by the unprecedented demand for the Company's products, which are meters and control systems for power and process operations. Twenty-three universities and engineering colleges are represented in the class.

All of the young men in the class are graduate engineers with the exception of three, who have completed their junior year in engineering and will return to school in the Fall.

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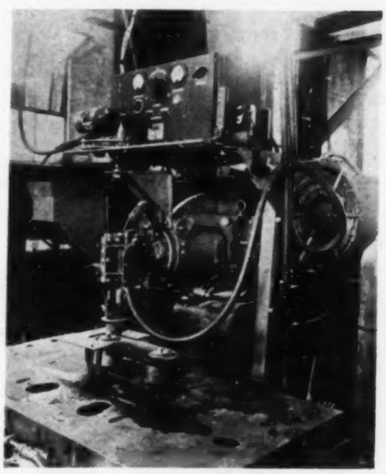
The course consists of lectures on the theory of Bailey Meters and Control Systems as well as factory training in the assembly and calibration of Bailey equipment. Also included is work in the Cleveland Main Office where the engineers obtain experience in the proper application of Bailey Equipment as well as practice in drawing up specifications for those applications.

They also spend a limited amount of time in the Research Laboratory where they study new equipment and instrument applications being developed by Bailey Meter Co. The course is concluded with a temporary assignment to one of the closer branch offices where the engineers gather actual experience in the installation and field calibration of Bailey Meters and Control Systems.

The course is conducted by R. E. Sprenkle, Director of Education, and J. H. Dennis, Ass't. Director of Education. They are assisted by other Bailey Engineers and experienced factory mechanics.

Upon completion of the training course, these engineers will become part of Bailey Meter Company's staff of over 100 resident engineers in 35 industrial areas throughout the United States and Canada where they will be available to advise and assist power and process engineers in solving their measuring and control problems.

Eccentric Guides Unionmelt Welding Head to Make Small Circular Welds



A circular weld, 3 in. in diameter joins bushings to side plates in the manufacture of large-size conveyor links. The Unionmelt Type U welding head is guided in a circle by a small motor-and-gear-driven disk with an eccentric pin. The combination of the standard hinge mounting on a standard carriage with the drive gears in the free wheeling position allows the Unionmelt welding head to move in a circle when driven by the eccentric pin. For a circular mold the center of the driving pin must be directly above the welding rod.

The bushing is water cooled to prevent drawing the temper. The knobbed covers resting on the top of each bushing connect when in the welding location, with a foot treadle beneath the table. Pressure on the treadle makes a water-tight seal and prevents the granular Unionmelt composition and the seam from getting wet.

The weld is completed in 30 seconds. By shifting the motor and eccentric pin to the other end of the slot, the welding head is swung into position to make the second weld. With this machine the operator can make ten links (40 welds) per hour.

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Converting to Welded Design Cuts Costs 20% ... Speeds Delivery

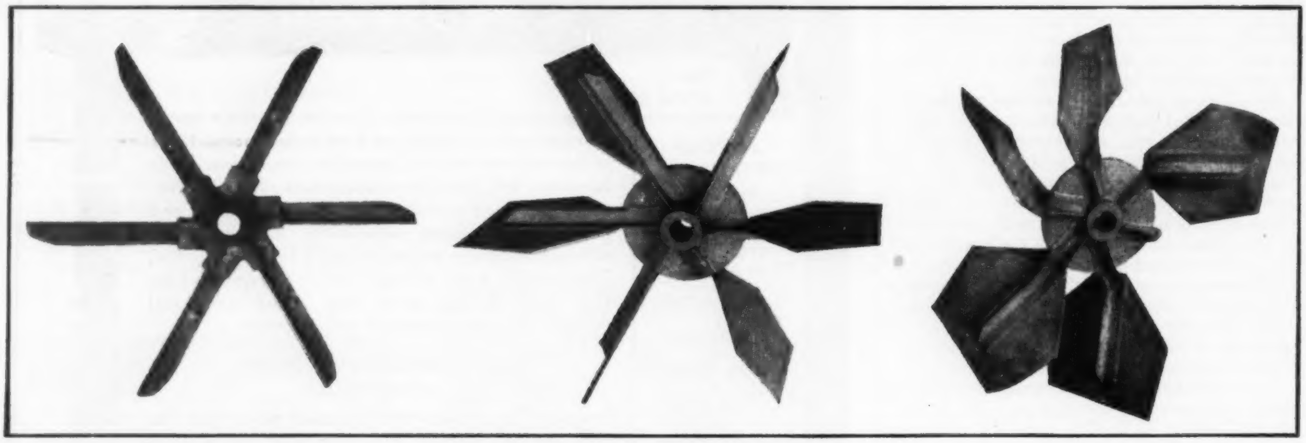

Fig. 1. Original construction. Riveted steel blades cast in iron hub. Cost approximately 25¢ per pound including riveted blades.

Fig. 2. Present all-welded steel construction. Steel blades and spokes arc welded to a steel plate hub. Cost approximately 20¢ per pound.

Fig. 3 Damaged all-welded steel impeller shows welds intact.

By W. R. Patterson, Superintendent
Dixie Manufacturing Company
Baltimore, Maryland

PART of our business is building planing mill exhaust fans for all types of industrial applications. Since each unit must be built to individual order, our shop fabricating methods must be very flexible if costs are to be held down. Arc welded construction has proved to be the only practical solution to this manufacturing problem.

Arc welding enables us to use all types of mild carbon and stainless steels with a resulting stronger product. By eliminating many time-consuming delays waiting for parts originally needed for this work, our manufacturing schedule has been cut from 4 months to 4 weeks. This prompt delivery gives us a decided sales advantage to customers requiring quick shipment.

The superiority of our welded design has already received wide customer acceptance. A number of old line customers now insist they will accept nothing but welded construction.

The impeller unit (Fig. 1) was originally constructed by casting the fan blade spokes into an iron hub. To these spokes we riveted the fan blades at a total unit cost of approximately 25¢ per pound. Under heavy load conditions, a break in the hub would cause the impeller to "explode" resulting in major damage to the blower unit and bothersome delay for the customer making repairs.

The present all-welded impeller (Fig. 2) has the blade spokes, consisting of two angles, arc welded to a flame-cut steel plate hub. The blades of shear-cut plate are welded to those spokes The cost of the arc-welded impeller is approximately 20¢ per pound, representing a reduction in cost of approximately 5¢ per pound or 20%.

The greater strength of the welded construction is illustrated by a mishap in which a heavy block was accidentally sucked into the blower intake. The photo (Fig. 3) shows how the blades were bent. Although the force of the mishap sheared the steel angles, the welds themselves remained intact.

The all-welded drive-shaft foundation base (Fig. 4) replaces a heavy cast base. Component parts are sheared from steel plate and assembled with arc welding, using "Fleetweld 7" and 400-amp. Lincoln "Shield-Arc" welders. A previous cast iron suction intake has been converted similarly to arc welded construction by fillet welding flame-cut plate to formed frame members.

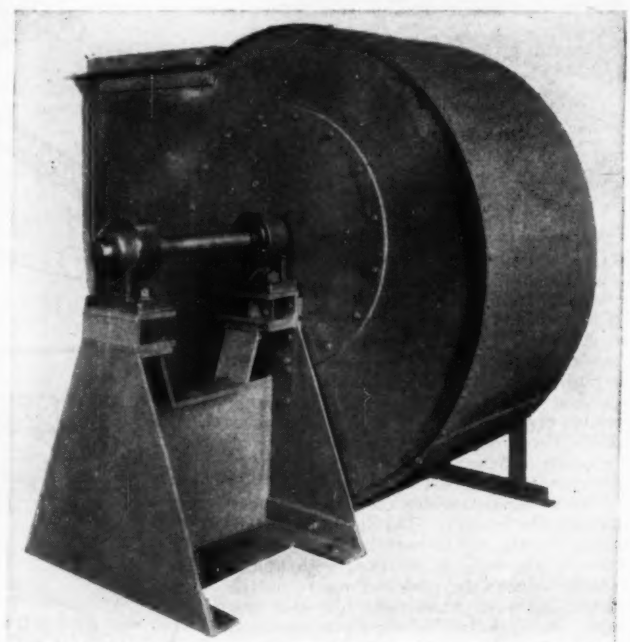

Fig. 4. Complete blower unit. Shows all-welded drive shaft base and suction intake. Cast base cost 15¢ per pound. Welded steel base cost 12¢ per pound.

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Link-Belt Announces "PA," Positive Action, Oscillating-Trough Conveyor

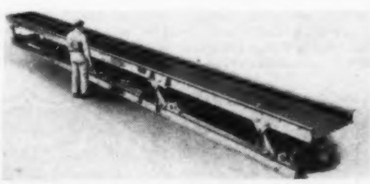
Following satisfactory performance of acactual installations, Link-Belt Co. now announce that they have developed a new conveyor, called the Link-Belt "PA," Positive-Action Oscillator, for the economical handling of a wide variety of materials in a horizontal path.

The new "PA" Oscillator is a positive-action, roller bearing, eccentric type oscillating trough feeder-conveyor, driven by a Link Belt Electrofluid Drive through a chain or V-belt reduction to the machine's eccentric shaft and connecting rod assembly.

It is available in standard trough widths of 12 to 48 inches to suit the capacity desired and character of the material to be handled—and in single trough lengths of up to 100 ft.

For longer carrying runs, two or more units may be arranaged in series, one discharging into the other, and each equipped with an individual motor drive.

Besides conveying material, the new "PA" Oscillator may also serve as a cooler, dryer or conditioning unit when jacketed, louvered or otherwise constructed for the service intended.



The trough is either pan type or constructed with channel steel sides. The standard trough is leak-proof and can be furnished with dust-tight covers or constructed for air and gas tight movement of the material. Conveyor trough can also be fabricated of corrosion and heat resistant metals.

Differing from the construction of oscillating-trough conveyors that Link-Belt has built previously, the "PA" Oscillator trough is supported on a series of short arms and adjustable torsion bars, having the effect of reactor springs.

These springs absorb the energy of trough-movement at each end of the stroke, at all points of support throughout length of trough.

The torsion bars and supporting arms are assembled in pairs, in common bases or mounts on an H-beam sub-frame, with each arm supporting one side of the trough.

Each torsion bar is fixed at one end, and is free to articulate in a steel-backed rubber bushing on other end, on which trough-supporting arm is mounted and keyed. Fixed end can be adjusted by means of set screws acting upon a self-energizing clamp which holds the bar.

The Link-Belt Electrofluid Drive accelerates the Oscillator smoothly yet rapidly, and requires a motor of minimum horsepower, based on the normal power requirement when operating under full load, rather than on the torque imposed by the initial resistance of the torsion bars when conveyor is started up.

The self-contained H-beam sub-frame on which the drive and trough-supporting arms are mounted, may be supported on springs where firm foundations are not available for the installation.

The "PA" Oscillator is particularly recommended for conveying sharp, jagged, abrasive, wet, oily, stringy, hot and other difficult-to-handle materials.

It is ideal for handling hot ores, hot sand and castings, machine shop chips and turn-

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• Keep Informed

ings, hot mill scale, sinter and clinker, as well as fine and lumpy materials.

The clean-cut and open construction of the conveyor trough makes it a desirable unit for handling foodstuffs and chemicals where contamination or corrosion is a problem, or where ease of cleaning is important.

The following are among the advantages o the oscillating-trough type of conveyor:

There is no spillage of material during conveying, as the positive action of vibrator mechanism moves the material steadily forward in conveyor trough and levels it off like water.

The wear on the trough itself is small; the forward motion of the material merely giving the trough a high polish.

There are no "joints" or operating parts to be attacked by abrasion of the material being conveyed.

Being mounted on a self-contained H-beam sub-frame, the alignment of conveyor is simple. The maintenance is low, even under severe operating conditions.

The conveying is done in a straight line, but separately driven sections of conveyor can be set at angles to each other, with one conveyor discharging into another.

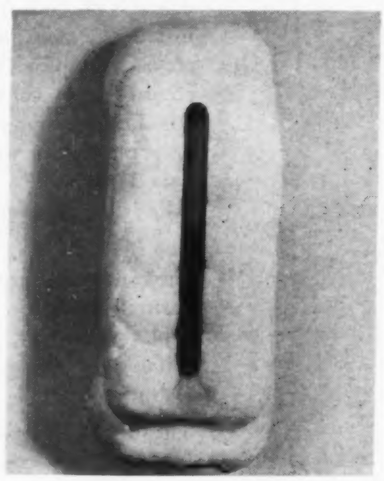
There is no return run to carry back material or require attention.

By the addition of partitions lengthwise along the trough, more than one material can be handled separately yet simultaneously without mixing, and discharged to different points along the conveyor, if desired.

A 16-page illustrated Book No. 2244 has been published to cover the new conveyor, and is now available. It contains installation views, layout drawings, selection charts, dimensions, weights, etc.

A copy of this new book will be sent to any interested reader promptly upon receipt of request.

New Jerguson Non-Frosting Gages



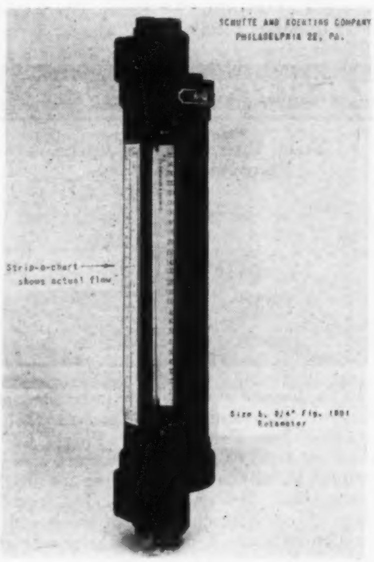
Jerguson Gage & Valve Co. now have ready for delivery a new Flat Glass Non-Frosting Gage, according to a statement just released by James Ford, Sales Manager. This new flat glass gage is ideal for refineries, recycling plants, and generally for any plants in the chemical or petroleum industries where low temperature fluids must be gaged. It may be made in any material to meet any operating conditions.

The gage is built with a special transparent frost preventing unit, sealed to the gage glass, which projects beyond the cover bolts so the frost cannot build up across the vision slot in the cover forging. The design of this new gage not only insures against frosting

but gives new accuracy of reading as compared with approximate readings with the use of frost plugs, according to Ford.

The Jerguson Flat Glass Non-Frosting Gage is available in both reflex and transparent types. It may be used with standard Jerguson valves. Jerguson also offers Tubular Non-Frosting Gages having double wall tubular glass with a vacuum between the two walls. Since no air comes in contact with the glass there is no condensation and it is therefore impossible for the glass to frost up. Jerguson Gage & Valve Co., 102 Fellsway, Somerville 45, Mass., will be glad to send further details and specifications upon request.

New Strip-O-Chart Simplifies Flow Readings



The Schutte & Koerting Co. Strip-O-Chart, designed for attachment to SK Rotameters with rigid, cast iron tube frames, provides a convenient, direct flow reading chart and eliminates the need for separate calibration charts.

The retaining strip for the chart is made of stainless steel, while the removable scale is reproduced on Chart film. The Strip-O-Chart will be made to customers' specifications and will contain the P. O., calibration units and other identifying information.

Both the mounting holder and the chart can be shipped immediately after receipt of orders. Complete information on the meter for which the chart is intended should be included with orders.

Strip-O-Charts can be obtained by contacting Schutte & Koerting Co., 1166 Thompson Street, Philadelphia 22, Penna.

Leak-Proof Ink Pump

A new rotary "leak-proof" ink pump for printing presses has been announced by the H. K. Porter Co., Inc., of Pittsburgh, Pa., makers of Quimby Pumps. The new pump, of unique design, dispenses entirely with the stuffing box. Instead of a stuffing box, Porter engineers have provided a means of collecting the overflow and returning it to the intake.

The new pump solves a problem that has long plagued printing-pressmen: leaky stuffing boxes. Because of the abrasive nature of printing ink, it is next to impossible to keep a stuffing box leak-tight.

Large users of printing ink brought their problem to Porter.

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"Let it leak" said Porter engineers, and forthwith designed a means of catching and returning leakage to the intake. The device has the effect of an automatic seal.

Known as "Model 2-B," the new pump differs from the standard line of Quimby rotary pumps in that the rotating assembly, which does the pumping, has non-frothing lobe-type rotors of special bronze.

Design of the body emphasizes accessibility to all parts for easy cleaning. Casing is cast iron, shafts of induction-hardened steel driven by external, herringbone steel gears in sealed gear case. Bearings are anti-friction, and the fluid pumped does not come in contact with either bearings or gears. The pump is designed for use with standard motor drives without the use of reduction gears.

For further information write to H. K. Porter Co., Inc., Quimby Pump Div., 1932 Oliver Building, Pittsburgh 22, Pa.

• BUSINESS CHANGES

Tube Turns Has Acquired Pennsylvania Forge

In the biggest move to date in its program of steady expansion, Tube Turns, Inc., has acquired the Pennsylvania Forge Corp. Announcement of the purchase was made by George O. Boomer, president of Tube Turns, Inc., and its affiliate, The Girdler Corp. He will be chairman of the board of the Pennsylvania firm, which is one of the nation's best known and most highly regarded manufacturers of flanges and custom forgings. James S. Kerwin, President, and W. T. J. Huggard, Secretary and Treasurer, and other officers will continue in their present capacities, and there will be no change in the personnel of the various departments. The business of the new subsidiary will continued to be operated under the name of the Pennsylvania Forge Corp.

For several years the Pennsylvania Forge Corp. furnished Tube Turns, Inc. with flanges in all sizes. Since large quantities of flanges as well as welding fittings are sold by Tube Turns, Inc., the subsidiary gives the Louisville organization complete control over the manufacturing facilities for all of the products in its extensive lines.

The plant of the Pennsylvania Forge Corp. occupies about $12^1/_2$ acres on the Delaware River, in Tacony, a suburb of Philadelphia. About seven hundred people are employed. The firm's forging and machining equipment are modern and afford capacity for the large scale production of quality work.

Foxboro Company Enlarges Its San Francisco Quarters

Having acquired the remaining space in the building which it occupies, at 266 Fremont St., the San Francisco branch of The Foxboro Co. is now settled in its rearranged quarters, with practically double the working space previously available. The Foxboro Co., with its main office and factory at Foxboro, Mass., is one of the leading makers of industrial instruments for measurement and control of process variables such as temperature, pressure, humidity and flow. The San Francisco branch is a sales office and ware-

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house for Foxboro products, and also a branch factory, providing repair service for customers in the West Coast territory. The shop is also fully equipped to assemble new Foxboro instruments and control valves, when time does not permit their shipment from the main factory.

The San Francisco branch is also the headquarters of Harry B. Brooks, Manager of the Pacific District, with supervision over all of Foxboro's branches west of the Rockies. Mr. Brooks, a veteran of 25 years' service with The Foxboro Co., is well known throughout his territory as an early-rising, far-riding, energetic engineer, for whom any problem of industrial instrumentation is only one more challenge to be met and overcome.

The Foxboro Co., with branches in nearly 40 cities of the United States and Canada also has branch factories at Pittsburgh and Dallas (as well as complete factories in Montreal and London). The San Francisco office was opened in 1914, at the time of the Pan-American Exposition. A small repair shop, which began operation in 1919, has steadily expanded its services, and now, in new and ample quarters, offers excellent facilities to users of industrial instruments throughout the West Coast area.

Lancaster Iron Works, Inc. Becomes Posey Iron Works, Inc.

The name of Lancaster Iron Works, Inc. has been changed to Posey Iron Works, Inc. The change was made through action of the Board of Directors in order to honor the President and founder of the organization, W. W. Posey.

There has been no other change in the corporate set-up and the same personnel and management continue to direct the functions of the organization. The respective divisions of the company are also being continued under their former identifications.

New Hunter Corporate Name Reflects Business Trend

Lansdale, Pa.,—Announcement by Knowlton D. Montgomery, President, discloses that the Hunter Pressed Steel Co., precision spring manufacturer of Lansdale, Pa., has changed its corporate name to Hunter Spring Co., more accurately to reflect the nature of the principal business in which the firm has risen to prominence since 1924, and which now constitutes over 80% of the company's activity.

The action is part of a 1948 company development program involving the construction and occupancy of a new main plant already housing the offices and the bulk of the company's production, and slated for formal opening in mid-September.

"In view of the fact that four-fifths of the company's production is in springs per se, and many of our friends have long referred to us by habit as the Hunter Spring Co.", stated Mr. Montgomery, "the move is actually overdue."

When Hunter was organized more than thirty years ago, the "Pressed Steel" part of the name was appropriate to the product. At that time grease cups were the principal items manufactured. Springs arrived on

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the Hunter scene in 1924 when the company was unable to obtain sufficiently uniform springs for its grease cups. To correct the condition, the company began to manufacture its own springs. That started the company on its way as a precision spring maker. From that time on, Hunter steadily expanded its business and reputation in the field. Today, it is a respected leader in the spring industry, and Hunter springs are distributed nationally, enjoying almost universal use in countless industrial and domestic applications.

The change of the firm's name to Hunter Spring Co. involves no changes in corporate affairs or in company personnel.

General Electric's Entire Welding Equipment Divisions Now Located at Fitchburg, Mass., Plant

The first complete large-scale welding equipment business to be located entirely within the New England states was completed recently when final components of the General Electric Company's Welding Equipment Divisions moved to Fitchburg, Mass., it was announced by C. I. MacGuffie, Welding Equipment Divisions Sales Manager.

The Sales and Application Engineering Divisions of the Welding Equipment Divisions have now joined the d-c welder manufacturing plant in Fitchburg, Mass. This move, coupled with the prior establishment of the a-c welder factory in Holyoke, Mass., makes New England one of the major arc welding centers of the world.

Under the new organization, sale of G-E welding products for the entire New England area will be handled by the Welding Engineering Sales Corp., Boston, Mass. In addition, portions of western Massachusetts, Maine, Vermont, and New Hampshire also will be served by direct factory sales from General Electric arc welding headquarters in Fitchburg.

The General Electric line of welding products to be sold and serviced from the new location is composed of a-c welders, including Inert-Arc and atomic-hydrogen welders, d-c welders, and automatic machine welding equipment. G-E welding electrodes and accessories also will be sold from the Fitchburg office.

Direct Sales and Service Facilities for G-E Arc Welding Equipment Available

Direct sales and service facilities for G-E arc welders, electrodes, and welding accessories are now available to industry at General Electric's Fitchburg, Mass., plant, according to a recent announcement by C. I. MacGuffie, manager sales Welding Equipment Divisions.

The new service is under the direction of Roger W. Wenzel, recently appointed sales representative of the Welding Equipment Divisions for central and western Massachusetts and the states of Maine, Vermont, and New Hampshire.

A native of Fitchburg, Mr. Wenzel has been located in the G-E plant since 1942, during which time he was largely engaged in the production and testing of welders.

Lincoln Electric Establishes Field Service Shops

The Lincoln Electric Co. of Cleveland, O., manufacturer of arc welding equipment, is now authorizing outstanding service and repair organizations in all the principal industrial centers of the United States to be Field Service Shops for Lincoln equipment. The shops are making immediately available in all parts of the country Lincoln factory parts and factory service.

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Each Field Service Shop is sending men to the Cleveland plant for training as experts in the repair and service of Lincoln welders of all types. These men will not only make repairs in their respective organizations but will be available for preventive maintenance service. All shops are offering a regular periodic checking and adjustment service to be done in the customer's own plant to prevent serious trouble and maintain efficient operation of the welders.

The Field Service Shops will also handle at factory prices parts for all types of Lincoln welders; AC transformer type, DC-AC, AC-DC as well as engine driven welders. Parts for the Hercules, Wisconsin and Continental engines used by Lincoln will also be stocked.

Field Service Shops have been authorized in industrial centers from coast to coast, while approximately every two weeks a new group of men is graduated from the special service training course at the Lincoln plant to go back to their own organizations as expert welder repairmen.

Westinghouse to Activate Kansas City Plant for Jet Engine Production

D. W. R. Morgan, Vice President in charge of steam turbine and jet engine operations of the Westinghouse Electric Corp. at Philadelphia, Pa., has confirmed the announcement of the office of the Secretary of Defense that, under a joint plan between Westinghouse and the Navy, the company will reactivate and operate the Naval Industrial Reserve plant at Kansas City, Mo. The plant will be used for the production of axial-flow jet aircraft engines, a design which Westinghouse pioneered in this country.

Initial steps for reactivating the plant, built during the war and formerly operated by Pratt & Whitney Aircraft Division to build reciprocating engines for planes, are already under way. Some months will be required, however, to complete the layout, supply machine tools, test cells and auxiliary services, and install equipment necessary for manufacturing purposes.

Under present plans, some 1,500 to 2,000 employes will be required after machinery is installed. This figure may rise eventually to 5,000 depending on the progress of development and the needs of the armed services. Wherever possible local people will be hired. It will be some time—possibly months—before hiring will begin.

• LATEST CATALOGS

New Booklet Discusses Causes and Prevention of Roof Failures

Smoke, fumes and other corrosive agents produced by many industrial plants often make those plants the worst enemies of their own roofs, according to the new, illustrated, 24-page booklet published by The International Nickel Co., Inc. The booklet, "One Metal Roof...for the Life of Your Building", tells how these highly destructive forces can give roofing troubles an earlier start and increase repair bills.

Full data on a new, soft-temper Monel roofing sheet, designed to overcome severe roofing conditions, is presented in non-technical language in this booklet. This information is part of a general discussion of the qualities required for a lasting roof with minimum maintenance.

Some of the nation's notable buildings having Monel roofs are pictured in this new booklet. They include buildings of various sizes and types. The present condition of

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the Monel roofs, in some cases after 35 to 40 years of service in some of the most severe conditions in the country, is described.

In the last section of the booklet, a fully illustrated description is given of Monel's adaptability to current architectural and roofing designs and practices.

Copies of this new publication are available from The International Nickel Co., Inc., 67 Wall Street, New York 5, N. Y.

Stress-Strain Recorders

Stress-Strain Recorders. Bulletin 262, a new 32-page catalog of Baldwin stress-strain recorders and strain followers, is announced by The Baldwin Locomotive Works, Testing Equipment Department, Philadelphia 42, Pa.

The bulletin describes, with pictures and diagrams, the basic principles of the various types of Baldwin recorders; gives the distinguishing features of 24 different recorders for all common makes of testing machines; and describes more than 50 extensometers, compressometers and deflectometers that can be used with the recorders.

The bulletin also shows typical stress-strain curves as produced by recorders, includes common testing accessories, and four types of strain gages.

G-E Molded and Laminated Plastics

Pittsfield, Mass.—A 15-page illustrated bulletin (No. CDP578) describing G-E molded and laminated plastics has been issued by the General Electric Company's Plastics Division. The bulletin is devoted to a description of the design, mold making, and molding facilities of G-E Plastics Division and discusses G-E sealing caps and sleeves, G-E mycalex, G-E silicone rubber, and G-E 1422 high frequency insulation. High and low pressure laminates are summarized along with G-E silent gears, bearings, decorative surfaces, translucent sheets, and name plate materials. Property tables are included for reference.

Copies may be had by writing the General Electric Co., Chemical Department, Pittsfield, Mass.

G-E Metallurgical Products

Pittifield, Mass.—An eight-page illustrated bulletin (No. CDM-12) describing G-E metallurgical products has been issued by the General Electric Company's Metallurgy Division. The bulletin is devoted to a description of G-E cast and sintered Alnico, Cunife, Cunico, Vectolite, Silmanal, and various permanent magnet holding assemblies. Special alloys such as G-E Thermistors and G-E Hevimet are also discussed.

Copies may be had by writing the General Electric Co., Chemical Department, Pittsfield, Mass.

Electronic Proportioning Pyrometer Controller

A bulletin describing a proportional current-input electronic pyrometer controller has just been published by The Bristol Co., Waterbury 91, Conn. The bulletin describes the application of the new instrument in proportioning the current input to electrically-heated furnaces, ovens, plastic molding machines, salt pots, and other similar equipment to provide practically straight line control. The new bulletin, No. PB1237, can be obtained from The Bristol Co., 112 Bristol Road, Waterbury 91, Conn.

Elliott Type F Surface Condensers

The Condenser Department of Elliott Co., Jeannette, Pa., has just published Bulletin C-9 (16 pages) on their Type F Surface Condensers. Built in sizes from 500 to 15,000 sq. ft., the Type F Surface Condenser is available in both divided and non-divided water-box types. Bulletin C-9 includes data on condensate pumps, steam jet ejectors, duplex drainers, air leakage meters, as well as a pressure-temperature conversion table, chart for determining logarithmic mean temperature difference, and condenser formulas.

Page Announces a New Electrode Booklet

The Page Steel & Wire Div. of American Chain & Cable Co., Inc. has just issued a new booklet DH 45, Page Hard Surfacing Electrodes, which consists of the following grades: Page Special Manganese Nickel Shielded Arc Electrodes, Page Manganese Shielded Arc Electrodes, Page Manganese Nickel Bare Electrodes, Page High Carbon Shielded Arc Electrodes, and Page Medium Carbon Shielded Arc Electrodes. Each of these electrodes has been developed to provide a weld metal deposit whose particular properties are suited to definite welding applications and are outstanding in their field.

Page Special Manganese Nickel Shielded Arc Electrodes are an exclusive Page development. The weld metal does not normally

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contain any free carbides and, as it is air toughening, does not require quenching in water to render it tough. The weld metal deposit will be sound, free from pin holes and possess unusual strength and ductility.

For complete information on this exclusive Page development and on the other Hard Surfacing Electrodes, write to Page Steel & Wire Div. of American Chain & Cable Co., Inc., Monessen, Pa.

Warren Liquor Pumps

New Bulletin 245 recently released by Warren Steam Pump Co., Warren, Mass. fully illustrates and describes their line of Types "L", "LS" and "A" Liquor Pumps for process industries. These centrifugal pumps have a wide range of applications, which include pumping of hot or cold erosive or corrosive liquids. Sectional views in the bulletin clearly illustrate the mechanical features and the text covers technical details. Bulletin 245 available upon request.

Special Projects Charts a New Course for the Future

What it takes in the way of personnel and equipment to develop new processes and machines is related in Issue No. 3, 1948 of the "Kelloggram," published by The M. W. Kellogg Co. engineers of Jersey City and New York

The eight-page brochure describes for the first time the wartime and postwar activities of Kellogg's Special Projects Department in the Government program to develop such tools of tomorrow as rockets and guided missiles for military use; high speed turbines for supersonic aircraft; new type fuels; and high temperature alloys.

Seventeen photographs of some unusual test equipment—some of it to be found in no other laboratory—forcefully illustrate the article.

Culled from the issue are the following interesting facts: "a speed of 14,000 miles per hour—theoretically not impossible—would shoot a rocket across the Atlantic Ocean"; metal at high temperature actually "creeps" or permanently elongates; the materials engineer has over 40 metals from which to select the raw materials for new equipment; remotely controlled guided missiles will play an important role in the next war; a new electronic controlled pipe-bending apparatus capable of accurate bending of pipe eight feet in diameter—large enough to garage a limousine—has been perfected.

Socket Screw Folder Published by Bristol

A folder containing interesting information on the application of Multiple-Spline and Hex Socket Set and Cap Screws has just been published by The Bristol Co., Mill Supply Division, Waterbury 91, Conn. Copies of the folder, No. DM860, are available from the company.

New Booklet on Engineering and Manufacturing

R-S Products Corp. of 4530 Germantown Avenue, Philadelphia, has released a four-page folder on "Manufacturing-Engineering" facilities.

This organization is widely known for its valves of the butterfly or disc type and for its industrial furnaces for heat treatment of both ferrous and non-ferrous metals.

Less well known, but broadly treated in the present issue is its department of manufacturing and engineering. Here R-S specializes in the design and construction of new types, test models, and other "one-of-a-kind"

Continued on Page 62

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jobs which the usual machine-shop is not fitted to handle. Large food-processing machines for special purposes, freezing and tumbling equipment, containers for dry ice and liquid carbon dioxide gas, are typical of the products made.

R-S also re-conditions dry-ice freight cars and does large size erection jobs in the field.

Detroit RotoGrate Stoker Catalog No. 80

An attractive 48-page comprehensive catalog on the Detroit RotoGrate Stoker, a spreader stoker with continuously cleaning grates that discharge the ash at the front, has just been made available by the Detroit Stoker Co., whose Sales and Engineering Offices are in the General Motors Building, Detroit, Mich. and whose Main office and Works is at Monroe, Mich.

The book includes, in addition to a complete description of the stoker and its method of operation, many interesting typical installations including photographs of interiors, line drawings showing application to a wide variety of types and sizes of boilers, and a new airplane photograph of the Company's Works at Monroe, Mich. where the stokers are completely assembled and inspected prior to shipment.

Colorful Bulletin Presents Improved Variable Speed Motors

Presentation of new model U. S. Varidrive motors is made in a colorful and factful Bulletin just issued by U. S. Electrical Motors, Inc. The Varidrive, which enables a machine operator to obtain infinite speeds, is shown in natural colors in different capacities. This 16-page Bulletin is attractively compiled and shows in dramatic form how a variable speed motor can be applied to countless operations, to reduce operator fatigue and appreciably increase production. Interesting graphs and illustrations show new ways in which variable speed can be used with savings in man hours and in obtaining better production. A diaphanous view of the Varidrive shows the operating principle of the motor. Supplementary drawings in full color detail major improvements in design. A copy of this very attractive four-color Bulletin may be obtained by writing to U. S. Electrical Motors, Inc., 200 East Slauson Ave., Los Angeles 54, Calif.

Stainless Piping Systems

"Taylor Forge Stainless" provides a new and more economical approach to flanged piping, which the manufacturers report to have decided advantages. Four-page, illustrated Bulletin 483 includes drawings, dimensions and prices of new type fittings and flanges, available in Stainless 304, 347, 316 and other materials. Taylor Forge & Pipe Works, P. O. Box 485, Chicago 90, Illinois.

Bristol Publishes New Socket Screw Catalog

A new 36-page socket screw catalog, describing both Bristol's Hex and Multiple-Spline Socket Screws, has just been published by The Bristol Co., Mill Supply Division, Waterbury 91, Conn. The new catalog contains much valuable engineering data and information on the correct application of socket set and cap screws and on stripper bolts and pipe plugs. Included are illustrations of the styles available, and detailed data is given on sizes, dimensions, prices, shipping weights, and specifications. Copies of the new catalog, No. 854, may be obtained from The Bristol Co., 112 Bristol Road, Waterbury 91, Conn.

EValpak

East Chicago, Ind.,—A new Edward catalog section 12-R, describing all types of EValpak die molded packing, has been issued by Edward Valves, Inc., East Chicago, Ind.

EValpak is furnished in sets with each set containing two types of packing. The top and bottom, or outer, rings of each set are wire inserted jacketed rings while the center rings are die molded plastic rings. Bulletin gives full details and prices of EValpak sets for each size and pressure class of Edward steel valves.

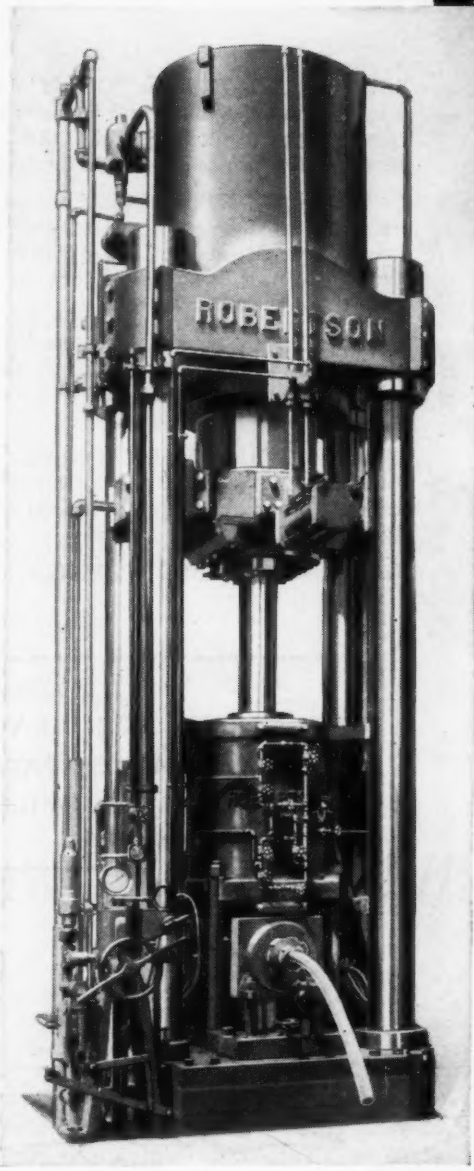
SKF Publishes New Pillow Block Book

Philadelphia—SKF Industries, Inc., has issued an abridged edition of its general catalog on ball and roller bearings that includes a special section dealing with the various types and sizes of pillow blocks manufactured by the company and data on their mounting, lubrication and maintenance.

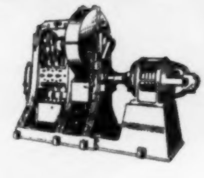
While lacking the detailed technical information of the general catalog, the 76-page booklet devotes considerable space to such engineering principles as load calculation, selection of shaft and housing tolerances, and conversion tables.

Distribution of the catalog will be made principally through approximately 800 distributor outlets and the company's 19 district and branch offices.

They're "GEMS" of Craftsmanship

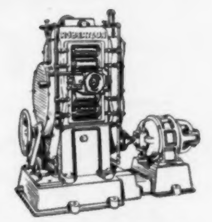


We design and build all types of lead encasing machinery and hydraulic equipment including Extrusion Presses, Hydraulic Pumps, Melting Furnaces and Pots, Dies, and Cores, Lead Sheath Stripping Machines and Special Equipment for Special Uses.



Hydraulic Pump

Closed Lead Melting Pot



Lead Sheath Stripping Machine

...they're Robertson

Designed and built by master craftsmen constantly mindful of the ultimate application of Robertson Equipment. It is this recognition of your problems plus the accumulated knowledge and experience of more than 89 years' specialization in the design and manufacture of high pressure hydraulic equipment that assures steady, uniform output . . . lower operating and maintenance costs. Let us help you solve your lead encasing problems.

JOHN Robertson
COMPANY INCORPORATED
121-137 WATER STREET, BROOKLYN 1, NEW YORK
Designers and Builders of all Types of Lead Encasing Machinery
Since 1858

Here's what they're saying about the two HUSKIEST members of

THE SKF FAMILY OF PILLOW BLOCKS

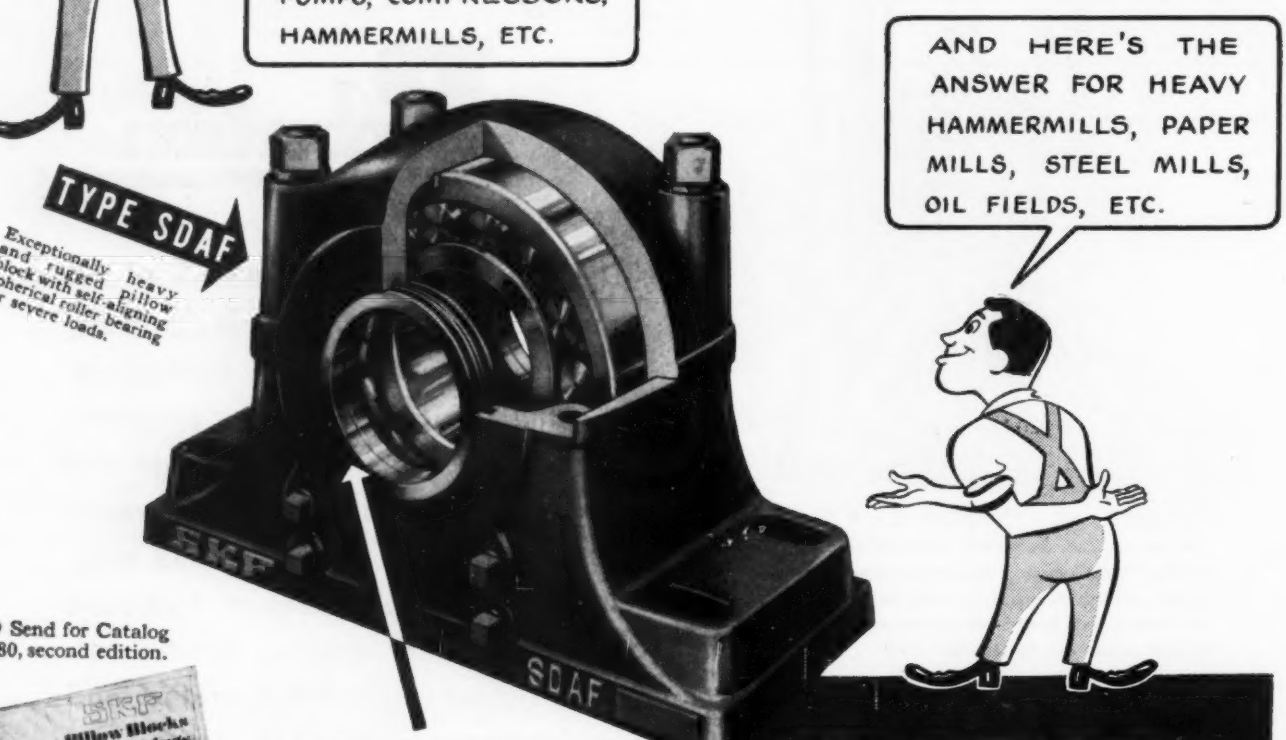
"Always get SKF for the TOUGH jobs!" is a byword in mills, mines and factories where these compact, split SAF and SDAF Pillow Blocks and Bearings are now in service.

Consider SKF Pillow Blocks from an engineering point of view: Rugged, easy to install, inspect and lubricate—equipped with SKF's exclusive Triple-Seal rings to keep lubricant *in* . . . dust, dirt and water *out!*

On any job—under any load conditions—there is an SKF Pillow Block and Bearing which will make your equipment operate consistently at a lower cost.

Need some of these husky Pillow Blocks and Bearings? Write us for the name of your nearest stock-carrying Authorized SKF Distributor. 6500

SKF INDUSTRIES, INC., PHILA. 32, PA.



● Send for Catalog 280, second edition.

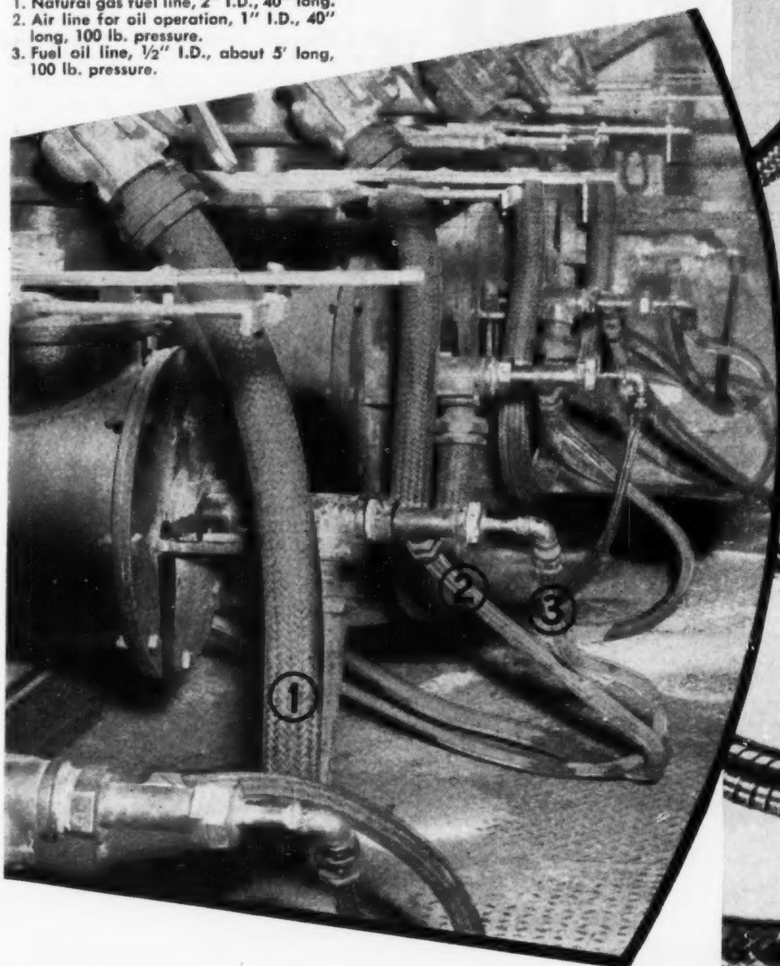
Triple-Seal Rings

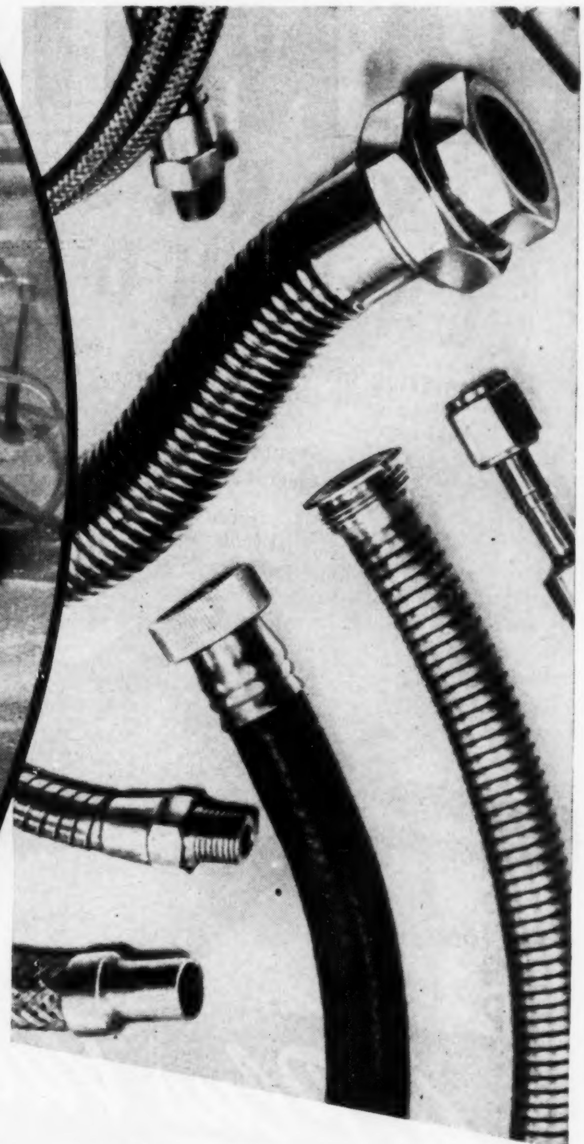
Two split piston rings are located on each side of the bearing assembly. *Inner* rings serve as internal flingers while *outer* rings keep foreign substance from entering the pillow block. Because these rings are not locked to the shaft, they are free to locate themselves whenever shaft expansion occurs.

SKF

PILLOW BLOCKS

1. Natural gas fuel line, 2" I.D., 40" long.
2. Air line for oil operation, 1" I.D., 40" long, 100 lb. pressure.
3. Fuel oil line, ½" I.D., about 5' long, 100 lb. pressure.





Down Time Saved

. . . WITH *Flexible Metal* CONNECTORS

Here's a bank of continuous billet heating furnaces, fueled by natural gas, and fitted with oil burners for standby service. Each furnace, therefore, needs three connections for its fuel supply: natural gas, oil, and an air line for oil operation. This presented a problem to the steel mill. If rigid piping were used, the need for frequent cleaning and adjusting of each burner would mean considerable loss of time in dismantling and assembling. The solution was American Seamless Flexible Metal Tubing in three different sizes, fitted with heatproof, re-attachable couplings.

American Seamless is usually made in bronze, but is also available in stainless steel and other metals; it is flexible tubing in one piece—no joints or welds. Several types of interlocked, strip-wound flexible hose in copper, copper alloys, nickel alloys, aluminum and steel complete the basic "American" line.

We believe industry has literally millions of opportunities for advantageous use of flexible metal connectors. Shown above are a few of thousands of special assemblies which "American" has designed for specific jobs. Send us your problem and we'll go to work on it. There's no charge for our engineering service.

4826

ANACONDA
from mine to consumer

American
METAL HOSE

THE AMERICAN BRASS COMPANY
American Metal Hose Branch
General Offices: Waterbury 88, Connecticut
Subsidiary of Anaconda Copper Mining Company
Throughout Canada:
THE CANADIAN FAIRBANKS-MORSE COMPANY, LIMITED

HANNIFIN

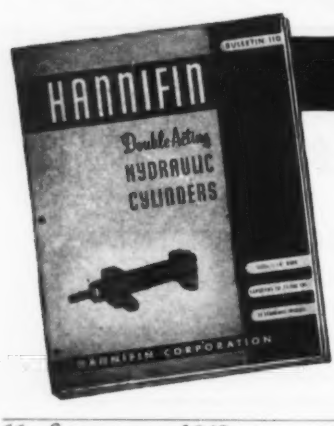
(*Below*) Hannifin Hydraulic Cylinders contribute to the precision performance of MORRIS MACHINE TOOL COMPANY'S 12 spindle "MOR-SPEED" high production machine for performing reaming operations on automotive cylinder blocks

...IN THE MACHINES YOU *Use!*

IT'S a better machine, when it's equipped with HANNIFIN *TRU-BORED* Cylinders. You get smooth, full-power performance; long lasting maintenance-free service. Look for the name "HANNIFIN"; it's a mark of QUALITY and a sign of modern engineering!

...IN THE PRODUCTS YOU *Build!*

YOU know it's *good* and your customers know it, too, when you use precision-built Hannifin Cylinders in products you build. Take advantage of the service Hannifin offers! Cylinders engineered to fit your requirements. Prompt, dependable delivery.



ASK FOR A COPY OF THIS BULLETIN!

- Everything you want in Hydraulic Cylinders! A big 52 page catalog listing standard Hannifin Cylinders, complete with specifications, dimensions, and engineering data. It's easy to get the cylinder that's *specially* designed for your job right out of Hannifin's *standard* line. Ask for Bulletin 110-X.

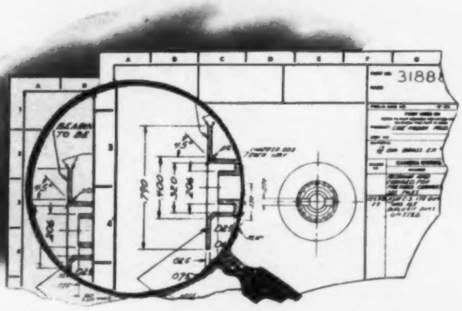
HANNIFIN CORPORATION

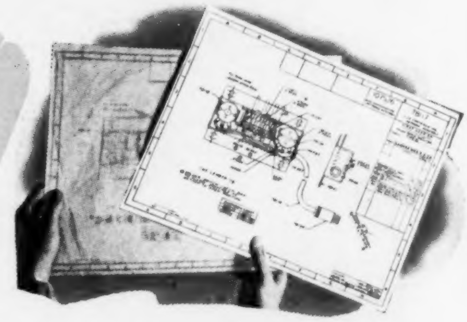
1101 S. Kilbourn Ave. HANNIFIN Chicago 24, Illinois

AIR CYLINDERS • HYDRAULIC CYLINDERS • HYDRAULIC PRESSES
PNEUMATIC PRESSES • HYDRAULIC RIVETERS • AIR CONTROL VALVES

Nationwide Sales and Service

Because it's photographic... this new intermediate paper gets more out of every drawing





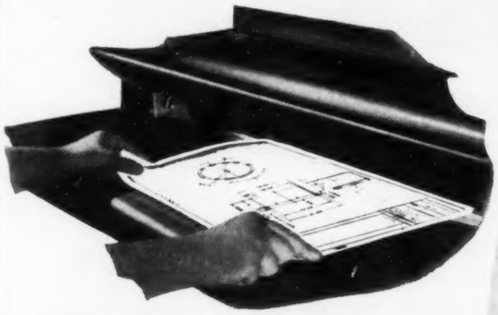
Uses photography's unique ability to step up contrast in reproduction... Silver-sensitized, photographic . . . Kodagraph Autopositive Paper has the ability to increase contrast in reproduction—to produce intermediates as good as originals—*and better.* Shop prints, too, are sharp, clear, thanks to the brilliance of these intermediates—to their extra thinness, even translucence.

Assures quality reproduction—even from "tough" originals . . . No question about quality with Kodagraph Autopositive Paper. Weak pencil tracings come through with ink-line density. Also tough "unprintables"—opaque drawings, faded originals, blueprints, direct process prints—originals of every type.

THE BIG

Kodagraph Autopositive Paper

NEW PLUS



Seeing is believing... Ask your reproduction department or local blueprinter for samples of intermediates made on Kodagraph Autopositive Paper—also shop prints made both from these intermediates and from original drawings. You'll see the difference . . . the outstanding advantages of Kodagraph Autopositive Paper.

Gives more . . . on present equipment . . . Kodagraph Autopositive Paper is easy to use. Nothing new to buy . . . it prints direct-to-positive . . . in ordinary room light . . . on regular blueprint or direct process equipment or in a vacuum frame. Nothing new to learn . . . simple photographic processing—no darkroom—no negative step. What's more, finished intermediates are tough, long-lasting . . . deletions, drawing-board changes are readily made, redrafting costs kept to a minimum.

EASTMAN KODAK COMPANY
Industrial Photographic Division
Rochester 4, N. Y.

Mail coupon for FREE booklet

16

Eastman Kodak Company
Industrial Photographic Division
Rochester 4, N. Y.
Please send me a copy of The Big New Plus—your booklet about Kodagraph Autopositive Paper and the other papers in this new Kodak line. I have
☐ direct process ☐ blueprint ☐ contact printing equipment.

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Kodak

THAT GEAR IS BUILT AROUND A

A dished head-shape forms the web of this crank gear.

Tire curing press built by The McNeil Machine & Engineering Company of Akron, O. Its dome-shaped steam box also started as a Lukens Head-Shape.

Formerly a casting, this gear is now built up by welding a rolled steel rim around a Lukens Dished Head-Shape, adding the one-piece hub and crank forging, and then cutting the teeth. Being a plate product, it is strong, dependable and inherently free from blowholes and other defects.

Lukens supplies the steel plate web for this gear, a head-shape, already formed as you see it here. The press manufacturer starts to work, therefore, on a semifinished product, applying his labor and machinery to finishing operations. Thus the use of Lukens Head-Shapes helps him speed production while also practically eliminating scrap losses.

Designers interested in the use of Lukens Head-Shapes will find 3,868 different styles and sizes described in Lukens Manual No. 1, "Flanging and Pressing". Select the shape meeting your needs, transfer its dimensions to your drawing and you've taken the first big step toward important savings in time and money.

For a copy of this manual, or for "Heads in a Hurry" listing the carbon steel heads ready for immediate shipment, write Lukens Steel Company, 402 Lukens Bldg., Coatesville, Pa.

Visit us at the Shows!

Booths 9 and 10
The National Chemical Exposition
Chicago Coliseum
October 12 thru 16

Booth 320
National Metal Exposition
Convention Hall, Philadelphia
October 25 thru 29

LUKENS
HEADS

FOUR INCHES TO OVER TWENTY FEET IN DIAMETER

• • SPEED SCRAP TO THE MILLS TO MAKE MORE STEEL • •

If you're interested in valves that will give you any or all of these operating advantages then you'll be interested in

NON-CONTAMINATING

MINIMUM MAINTENANCE

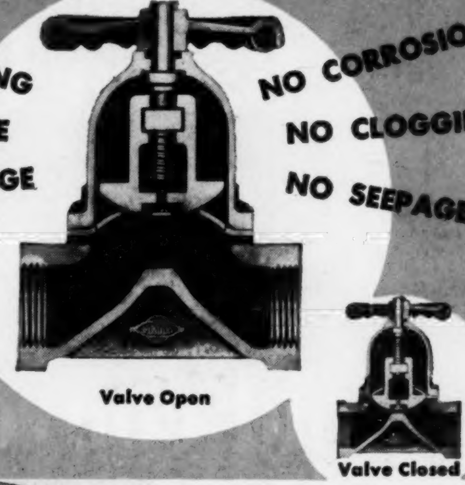
NO VALVE STEM LEAKAGE

NO CORROSION

NO CLOGGING

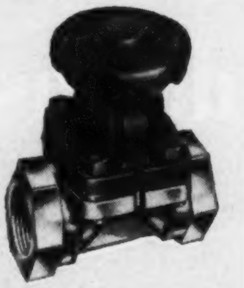
NO SEEPAGE

GRINNELL - SAUNDERS DIAPHRAGM VALVES



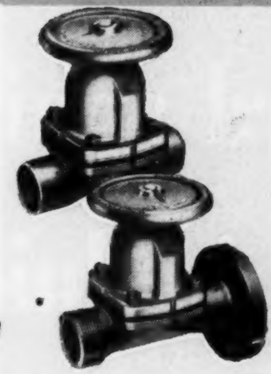
Valve Open

Valve Closed



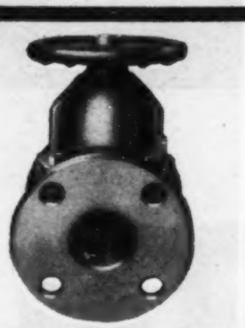
FOR CHEMICALS

Stainless Steel valves with special diaphragms are handling satisfactorily such corrosive chemicals as phosphoric, acetic and chromic acids.



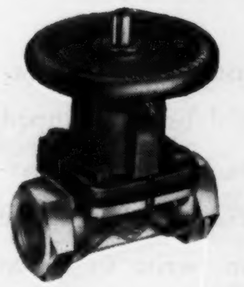
FOR BEVERAGES

Bronze valves with socket ends (left) and with hose threaded end (right), both with special white rubber diaphragms, are stopping leaks and cutting maintenance to the bone in breweries handling millions of barrels of beer.



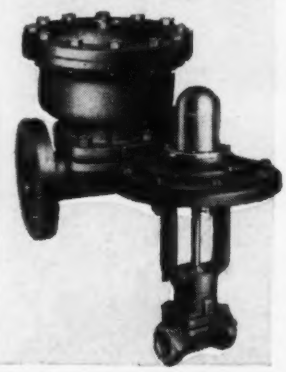
FOR PULP and PAPER

Rubber lined valves are setting new performance records handling pulp, alum and sulphuric acids in paper mills.



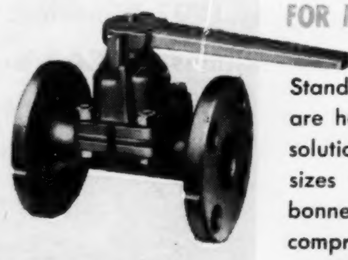
FOR TEXTILE PLANTS

Aluminum body valves with rising stems have won enthusiastic approval in bleacheries handling hydrogen peroxide and other chemicals.



FOR FOODS

Piston-operated valves (left) and air motor operated valves (right), both glass lined and with proper diaphragms, are providing remote control in plants handling sodium chloride, sodium hydroxide, sulphuric acid and fruit juices.



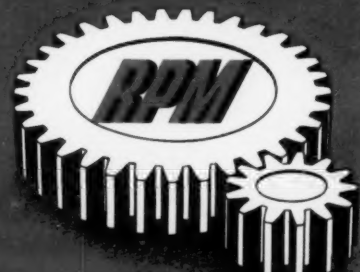
FOR MINES

Standard rubber-lined valves are handling highly abrasive solutions and slurries. Small sizes with quick-operating bonnets are widely used on compressed air lines to prevent leakage.

Grinnell-Saunders Diaphragm Valves may eliminate valve troubles and cut valve maintenance on your pipe lines. Available in any combination of valve bodies and linings, diaphragms and operating mechanisms. State your requirements or ask for Catalog 2-S on "Grinnell-Saunders Diaphragm Valves". Grinnell Company, Inc., Providence 1, R. I. Branch warehouses in principal cities.

GRINNELL

WHENEVER PIPING IS INVOLVED

HERE'S  TO FIT YOUR DRIVES

...WHEN YOUR NEEDS CALL FOR INDUSTRIAL GEARING

You can satisfy *all* of your industrial gearing needs by making Westinghouse your gearing headquarters.

Westinghouse facilities are unsurpassed for the design and manufacture of industrial gearing . . . custom-made to your requirements.

Your gearing problem receives the careful attention of designers of outstanding ability. Accurate manufacturing methods, a wide range of heat-treating processes, skilled operators, and thorough inspection and testing assure gears that meet every design specification and provide long, trouble-free service life.

Your gearing inquiries are given immediate attention. Your orders will be filled promptly . . . manufacturing facilities are ready.

THE PRACTICAL ANSWER TO YOUR RPM PROBLEMS

...FOR DRIVES UP TO 75 HP

The power that counts is power applied at the point of work. For drives up to 75 hp, the practical way to combine slow-speed output with high-speed motor efficiency is by specifying Westinghouse Gearmotors.

Just as a straight line is the shortest distance between two points, so Westinghouse Gearmotors transmit power most directly and with highest efficiency. Cumbersome drives such as belts and pulleys are eliminated . . . productive floor space is gained. They are easy to select for correct speed ratio . . . easy to install and service . . . adaptable for all types of drives and motors. The complete drive is in one single package.

Westinghouse offers a complete line of standard horizontal and vertical gearmotors, in a wide range of ratios, with a choice of motor types. Auxiliaries and non-standard types are also available for special applications. J-07264

★ ★ ★

Depend on Westinghouse for help on your gearing problems. You buy undivided responsibility for design, manufacture and servicing of all electrical and mechanical components. Call your nearest Westinghouse office, or write for Booklet B-3730. Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania.

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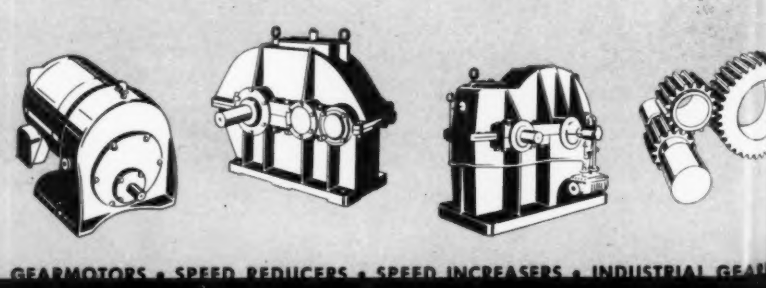
Westinghouse

RPM FITTED DRIVES



GEARMOTORS • SPEED REDUCERS • SPEED INCREASERS • INDUSTRIAL GEA

The Dart Truck Company recently installed Twin Disc Hydraulic Power Take-offs in 34 of its extra heavy-duty dump trucks currently hauling iron ore on the Mesabi Iron Range.

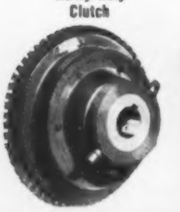
To smooth out the rough spots on this rugged job, Dart requested of Twin Disc a hydraulic drive designed with the following qualifications:

1. To increase wear-life and reduce maintenance on all power transmission units.
2. To "cushion out" sudden high-torque demands from the wheels.
3. To eliminate "front end jump" when the clutch is engaged on heavily-loaded vehicles.

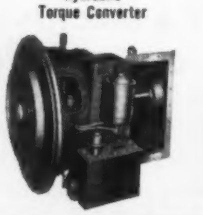
Mounted directly on the engine . . . the output shaft driving a conventional spring-loaded clutch which engages the input shaft of a 10-speed transmission . . . these Twin Disc Hydraulic Drives increase clutch facing life, due to the reduced clutch slip during engagement . . . reduce peak engine bearing loading, and, consequently, engine maintenance.

These new Twin Disc Hydraulic Power Take-offs are equipped with SAE housing flanges at each end to permit installation between the engine and standard transmission units. Available with 14.5″, 17.5″ and 21″ Couplings, they are applicable to engines and transmissions with ratings up to 300 hp. For complete information, write the Hydraulic Division for Bulletin 136. TWIN DISC CLUTCH COMPANY, Racine, Wisconsin (Hydraulic Division, Rockford, Illinois).

Heavy Duty Clutch



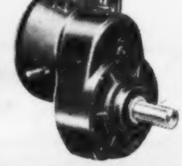
Hydraulic Torque Converter



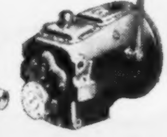
Tractor Clutch

TWIN DISC
CLUTCHES AND HYDRAULIC DRIVES
REG. U. S. PAT. OFF.

Reduction Gear



Marine Gear



SPECIALISTS IN INDUSTRIAL CLUTCHES SINCE 1918

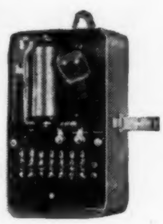
Digest

TIMELY HIGHLIGHTS ON G-E PRODUCTS

NEW CONTROL CATALOG READY

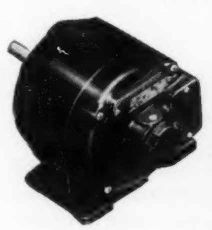
You'll find plenty of helpful, up-to-date pointers in G-E's new Condensed Control Catalog. In quick, easy-to-read form, it covers a-c and d-c control and accessories of widest interest to designers. It gives you features, ratings, dimensions, prices and where-to-use information that you'll want for handy reference. Especially valuable is a section on factors to consider in selecting control. For *your* copy, check Bulletin GEA-642 in coupon.

SUPER-SENSITIVE RELAY



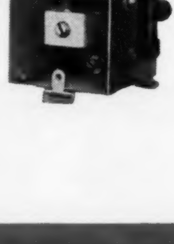
So sensitive is this G-E electronic relay that it responds to contact-closure periods as minute as .004 seconds. It permits use of delicate actuating contacts of low current-carrying capacity without their pitting, arcing, or sticking. With it, you can control a power circuit from an actuating circuit of as great a resistance as 500,000 ohms. It measures only $5\frac{1}{2}$ by $7\frac{1}{2}$ by $4\frac{1}{4}$ inches in its weather-resistant case. Check Bulletin GEA-4214 for full details.

FOR START-STOP SERVICE

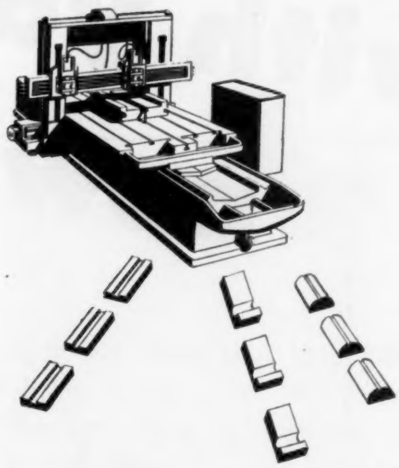


Designers favor the G-E fractional hp machine-tool motor because its firmly anchored windings keep it going under stop-and-go, plugging and momentary overload conditions. Totally-enclosed, it keeps out dirt and metal dust. Special ball bearings withstand thrust loads. Convenient terminal box permits quick, easy connections. Standard ratings are $\frac{1}{4}$, $\frac{1}{3}$, $\frac{1}{2}$, and $\frac{3}{4}$ hp. Send for Bulletin GEA-4120.

WORKS IN A VACUUM



With a G-E diaphragm-type pressure and vacuum switch, contacts open and close upon only a small change of pressure or vacuum in air, water, and oil-pressure systems. Use them to start small motors, or as pilot devices to control automatic starters for large motors. Made in a-c and d-c types, they're safe, long-lasting, easy to adjust, and low in installation and maintenance cost. More data in Bulletin GEA-821.



HOW TO DRIVE A PLANER FASTER

A planer table can be accelerated and decelerated at high speed—yet smoothly—with a G-E adjustable voltage drive. With more reversals per minute, faster planer operation is made possible, especially on short-stroke jobs and small runs.

The drive's wide speed range also makes the planer more versatile. The operator can adjust the cut speed to many different metals, yet keep return speeds fast. Quick response of the equipment to a limit switch allows accurate planing right up to shoulders and in pockets.

A pendant-type push-button station simplifies control. Cut and return speeds are independently adjusted from one rheostat enclosure. Ask a G-E engineer about the G-E planer drive or write for Bulletin GEA-3785.

General Electric Company, Section H668-64
Apparatus Department, Schenectady 5, N. Y.

Please send me the following bulletins:

- ☐ GEA-1437—Gear-motors
- ☐ GEA-3785—Planer drives
- ☐ GEA-642 —Condensed control catalog
- ☐ GEA-4214—Electronic relays
- ☐ GEA-4120—Fractional hp motors for machine tools
- ☐ GEA-821 —Diaphram-type pressure and vacuum switches

CONSULT YOUR SWEET'S! You'll find "everything electric" for machinery manufacturers in the General Electric section.

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Company ....

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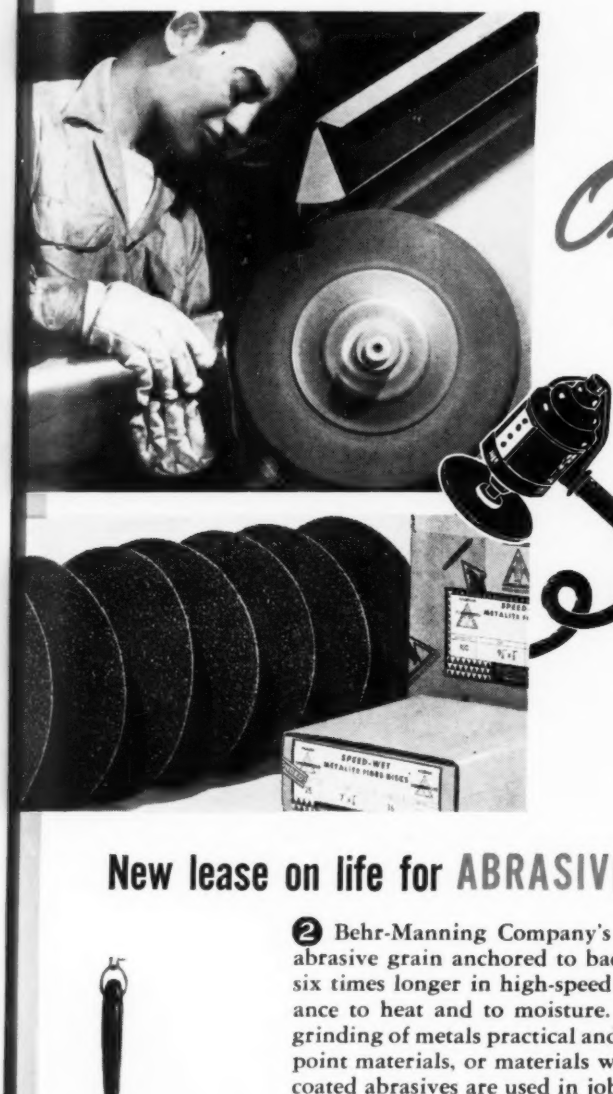
City .... State ....

COST 1/6 as much to produce!

❶ Spinning chucks machined from Densified Wood—compressed wood veneers impregnated with BAKELITE Phenolic Resin—provide major economies in spinning aluminum parts. First, their production cost is approximately a sixth that of similar forming dies made of metal. Moreover, low coefficient of friction of the dies prevents overheating of metal being worked. And they don't scratch the aluminum part being spun. In addition to its great wear and abrasion resistance, Densified Wood takes a permanent finish of remarkable grain and beauty. It has become a notably useful new material for many industrial and consumer applications.



Originality Unlimited!

—that's the thrill of working with plastics!

BAKELITE NEWS

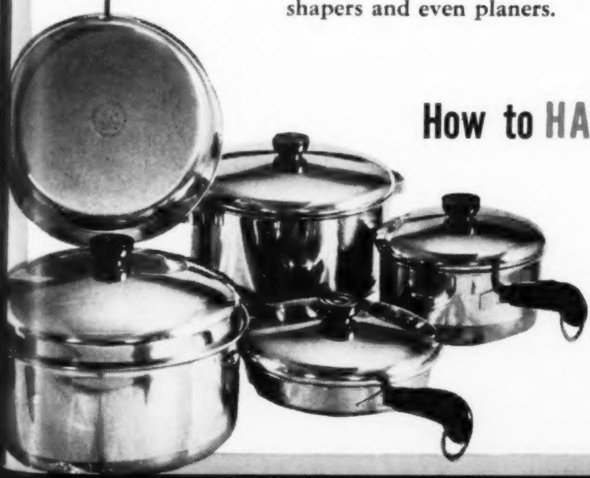
NO. 3

NOTES FROM BAKELITE CORPORATION ON BETTER, FASTER, LOWER COST PRODUCTION WITH "BAKELITE" PLASTICS

New lease on life for ABRASIVES!

❷ Behr-Manning Company's abrasive belts, disks and sandpaper—with the abrasive grain anchored to backing by BAKELITE Phenolic Resins—last five to six times longer in high-speed precision grinding service. The reasons: Resistance to heat and to moisture. The phenolic resin bond not only makes dry-grinding of metals practical and economical, but also wet-grinding of low-fusion-point materials, or materials which present a dry-dust or a fume hazard. These coated abrasives are used in jobs once done only by milling machines, profilers, shapers and even planers.

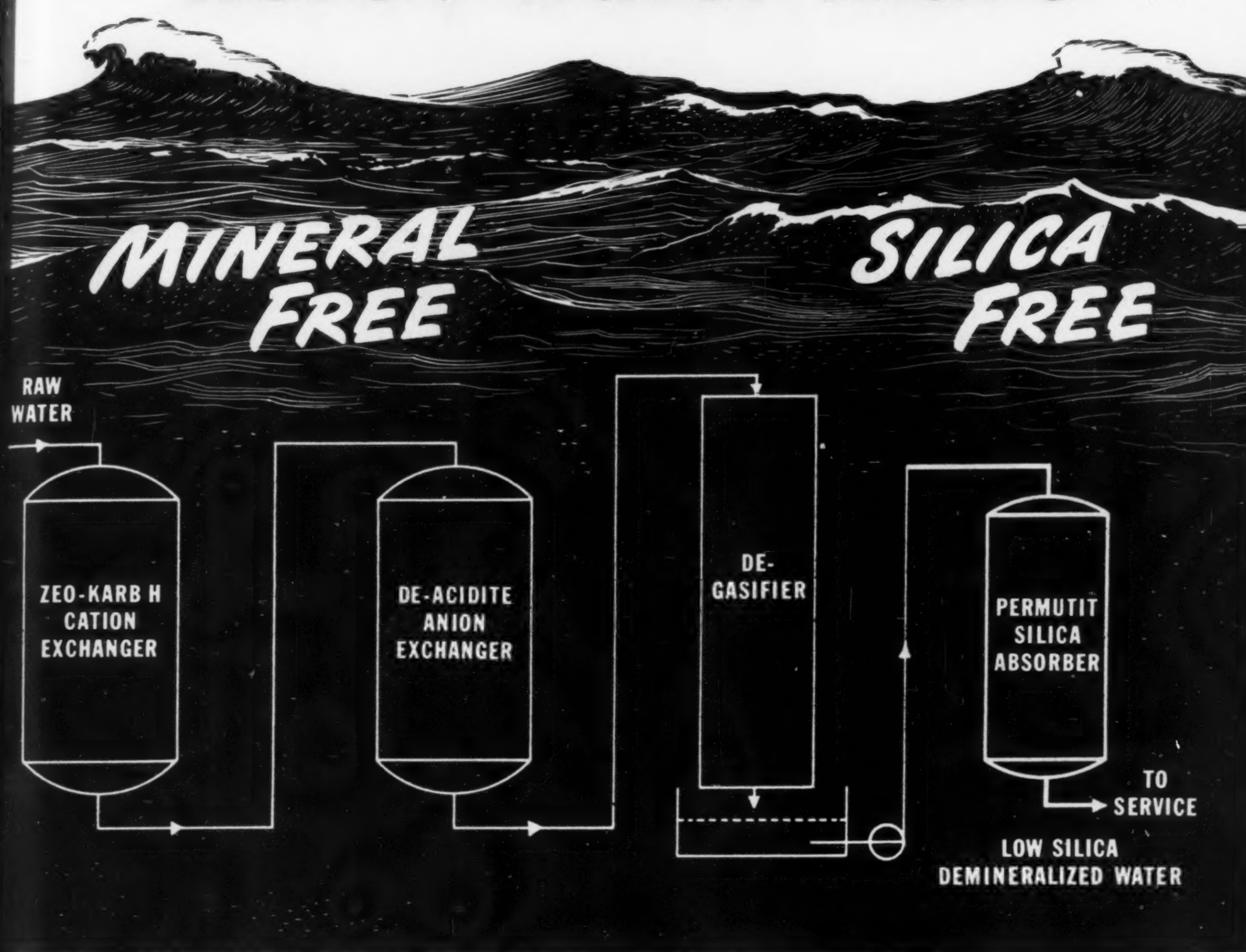
SPI NATIONAL PLASTICS EXPOSITION 1948 GRAND CENTRAL PALACE NEW YORK SEPT. 27—OCT. 1



How to HANDLE a hot problem!

❸ The makers of Revere Ware use BAKELITE Phenolic heat- and water-resistant molding material for the handles of their famous line of kitchen utensils. It retains its high mechanical strength even at the high temperatures associated with cooking. Its low conductivity keeps handles comfortable to touch. It is rapidly and economically molded to a lustrous finish. The material is unaffected by soaps, greases and food chemicals. More than a score of other leading utensil makers also prefer to use BAKELITE Phenolics for handles.

Here's water that's



This new Permutit chemical process produces the equivalent of evaporated make-up water at tremendous savings. Permutit has added to its ionic demineralizing plant this one-step cold process silica removal unit. The result: *low silica* (less than 0.5 ppm) *demineralized water!*

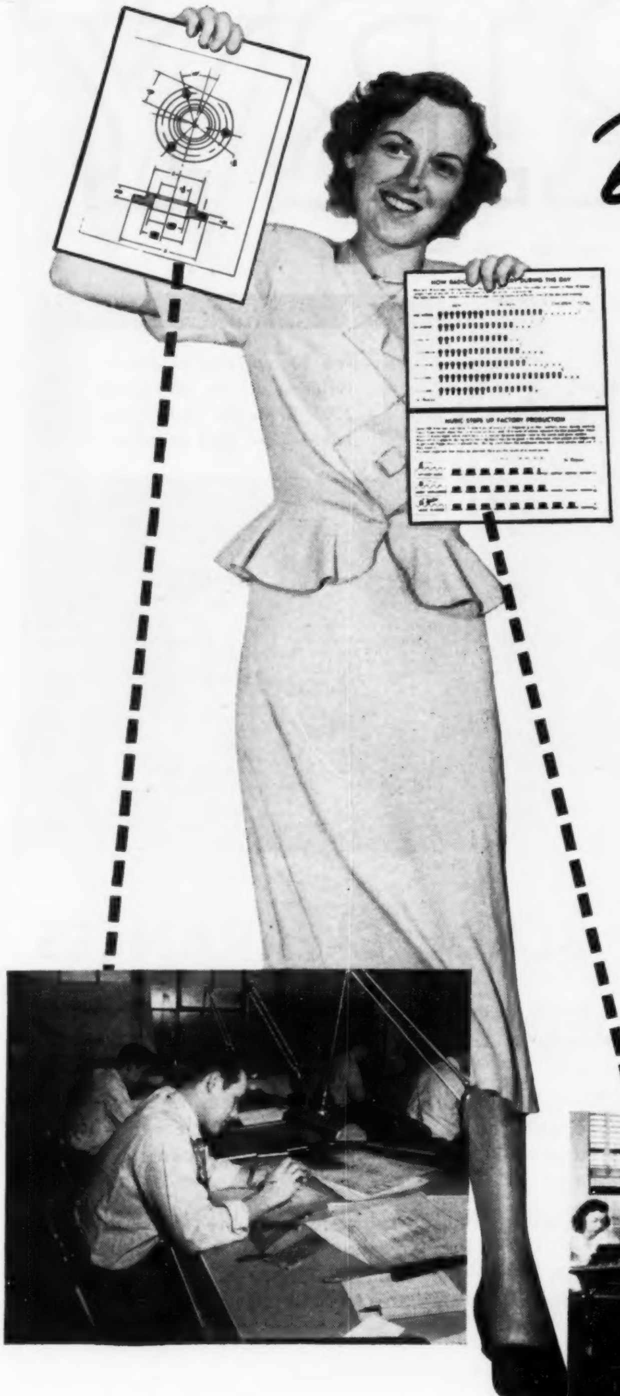
This two-step demineralizing process utilizes Zeo-Karb H, Permutit's acid-regenerated cation exchanger, to replace metallic cations with hydrogen ions. Thus, salts present in the solution are converted into corresponding acids. These acids are then removed from solution by De-Acidite, Permutit's resin anion exchanger.

For full details on this Permutit process, and on other Permutit products for power plants, write to The Permutit Company, Dept. ME-9, 330 West 42nd Street, New York 18, New York, or to the Permutit Company of Canada, Ltd., Montreal.

FOR 35 YEARS

Permutit

WATER CONDITIONING HEADQUARTERS



Double ADVANTAGES WITH BRUNING BW WHITEPRINTS!

Your engineers and draftsmen already make their drawings on translucent papers to facilitate reproduction. By using translucent or transparent materials in your general offices, too, you can get *double* advantages from Bruning BW Whiteprints! For Bruning BW Whiteprints provide greater convenience and speed when duplicate copies are needed *anywhere.* These positive prints are made directly from the master or original—in seconds, and without the use of a negative! They are exact duplicates—no chance for errors through transcription.

Bruning BW Whiteprints are exact, positive copies of anything drawn, printed, typed or written. The BW process is simple and clean—you need no darkroom, plumbing connections or exhaust ducts. BW equipment can be installed *anywhere* in your plant or office. Let us tell you the whole story of Bruning BW Whiteprints—and why they are used by so many industries and businesses. The facts are yours for the asking. Mail the coupon!

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Gentlemen: I want to know more about Bruning BW Whiteprints and equipment. Please send me information.

Name......................................

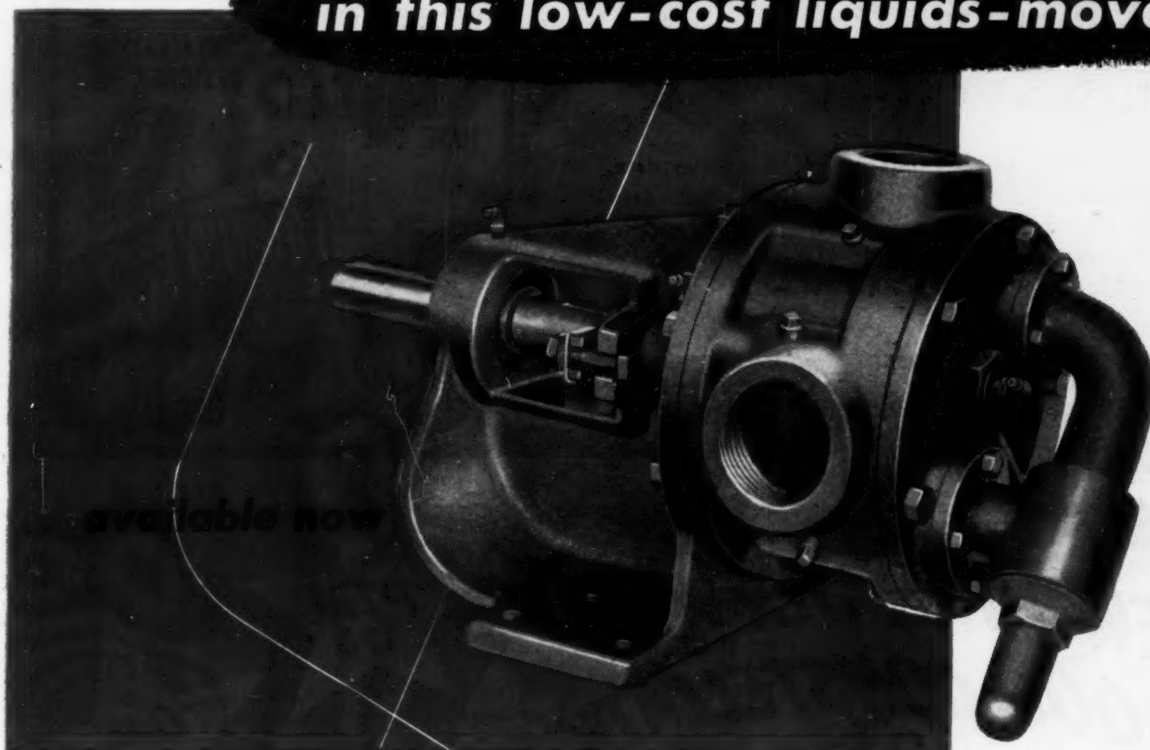
Company......................................

Street......................................

City......................................*State*..........

only 2 parts move

in this low-cost liquids-mover!



Yes, there are only two moving parts in Fairbanks-Morse Rotary Pumps. These exceptionally compact liquids-movers, with their simplicity of design, bring you low-cost pumping at high efficiency. A precision-cut rotor and pinion do all the work. There are no complicated parts to cause trouble . . . no worries about suction leaks . . . no vapor locks.

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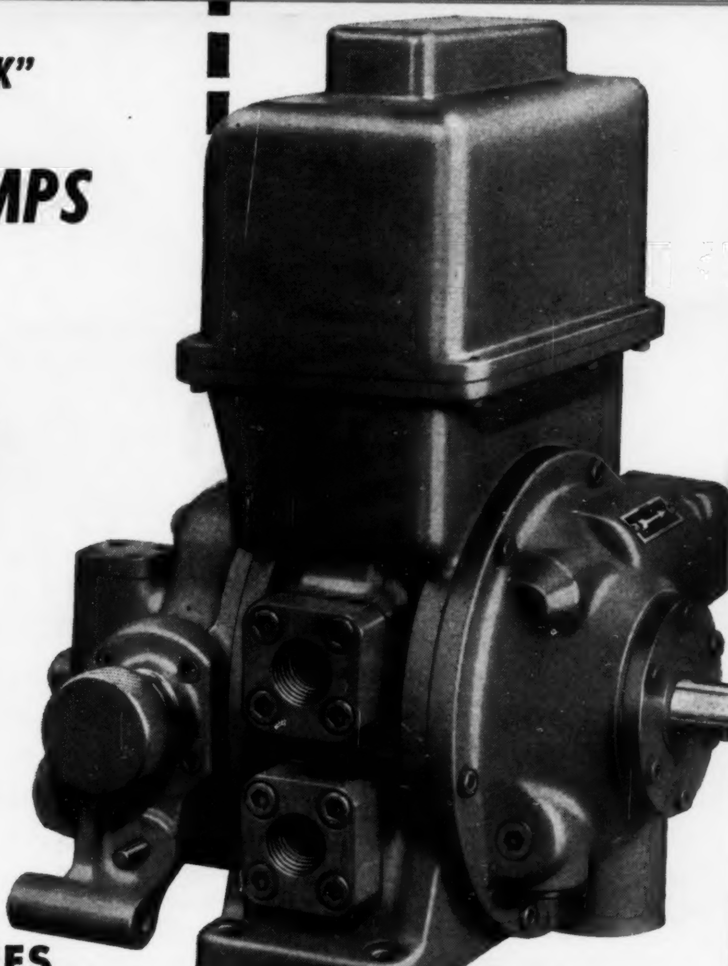
THE NEW OILGEAR "JK"

Trademark Reg. U. S. Pat. Off.

FLUID POWER FEED PUMPS

Are So Easy to Apply



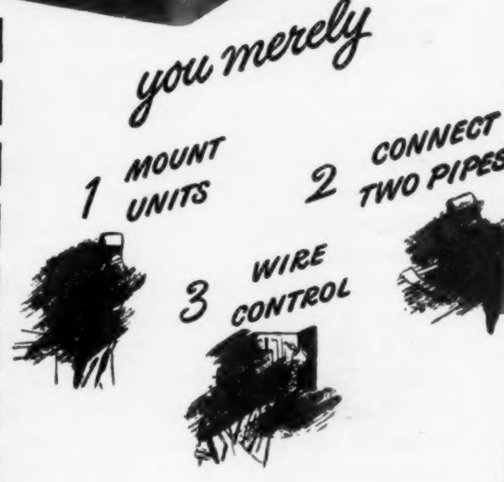
TO NEW OR OLD MACHINES

Simply connect a new, small Oilgear "JK" Feed Pump to an Oilgear cylinder and an Oilgear engineered control and you have a complete pushbutton and switch-controlled fluid power system. No hydraulic or electric application engineering is required. Merely follow standard recommendations in mounting units, connect pump to cylinder with two pipes and wire two solenoids on pump to electric controls. Oilgear supplies the feed pump, cylinder, control cams, limit switch panel, control panel and pushbutton station. Oilgear provides patented, tried and proven hydraulic and electric circuits.

You can improve your new and old machines without further congesting your engineering department or employing hard to get qualified hydraulic engineers. You cut production and assembly costs because *NO* mechanical control linkages . . . *NO* auxiliary valves, pipes or fittings are required. You do not have to risk delay, disappointment or malfunctioning. You avoid divided responsibility. You receive the full values inherent only in 100% Oilgear systems.

No other single change in a machine can contribute so much to simplified design, reduced costs or improved performance as the installation of the "JK" feed system.

Bulletin 44200 describes this small, compact packaged unit that incorporates feed pump, rapid traverse gear pump, control and relief valves as an integral unit; other features described are: wide range of feeds . . . consistently maintained pre-set feed rates, ease of servicing without disconnecting pipes or draining oil reservoirs, etc. Send the coupon for this bulletin today. THE OILGEAR COMPANY, 1307 W. Bruce Street, Milwaukee 4, Wis.



Oilgear furnishes all components and patented hydraulic and electric circuits.

The Oilgear Company
1307 W. Bruce St., Milwaukee 4, Wisconsin

Please send free copy of Bulletin 44200 on the new easy-to-install Oilgear "JK" Variable Delivery Feed Pump System.

Name..

Position..

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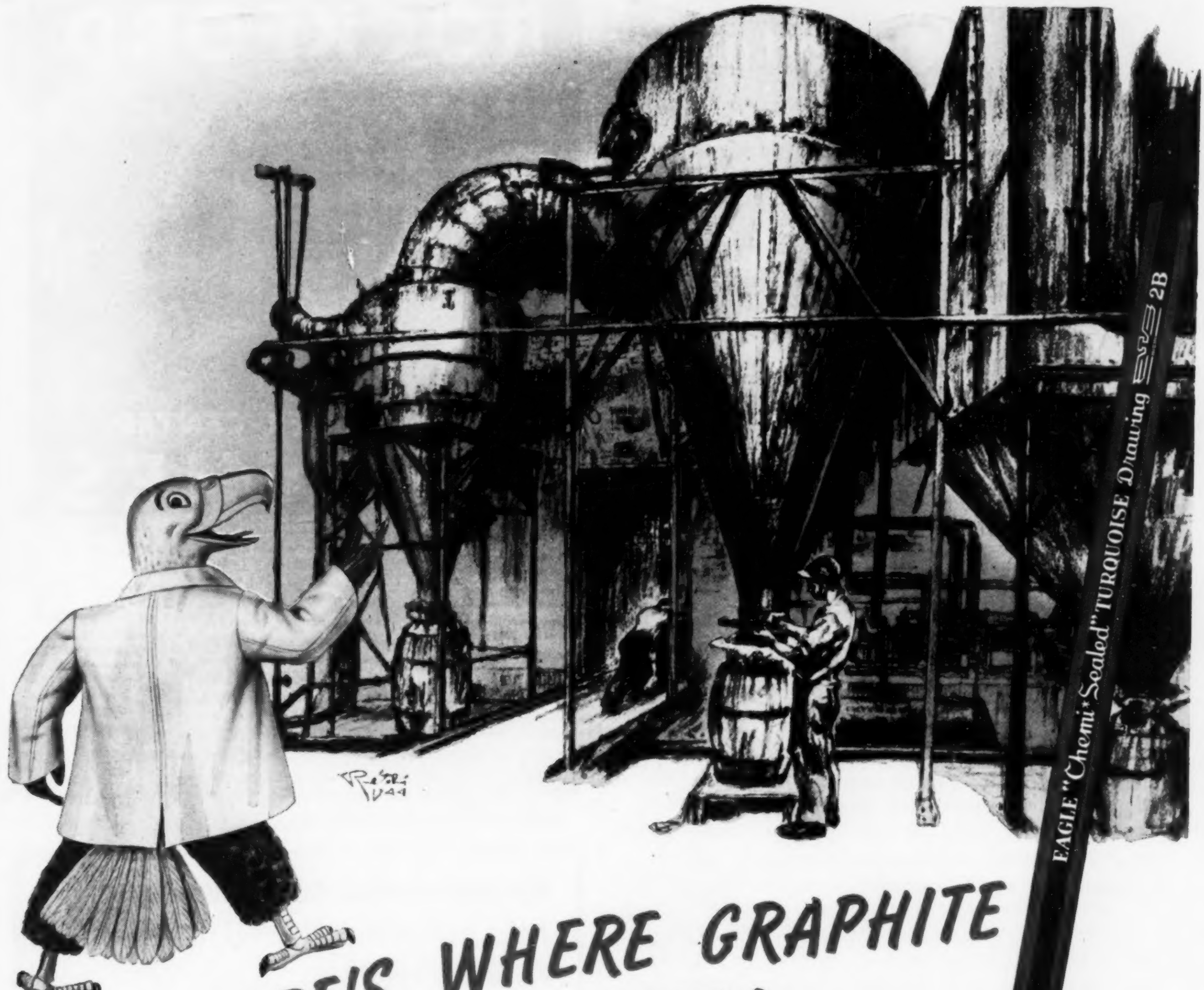
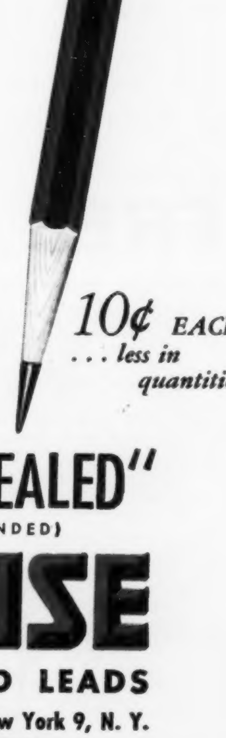
City.......................... *State*..................

Oilgear Fluid Power



HERE'S WHERE GRAPHITE MEETS ITS MASTER!



BECAUSE it is a natural lubricant, graphite stubbornly resists reduction to particles of extreme fineness. We knew we could make basically better drawing leads if only we could invent a mill for grinding graphite far finer than it had ever been ground before.

HERE'S OUR MIRACLE MILL, an exclusive patented Eagle process that utilizes the entirely new principle of making graphite *grind itself* down to micronic size . . . 1/25,000th of an inch. The particles average four times finer than in the graphite normally used.

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EAGLE PENCIL COMPANY, 703 E. 13th St., New York 9, N. Y.

Eagle Pencil Company of Canada, Ltd., Toronto

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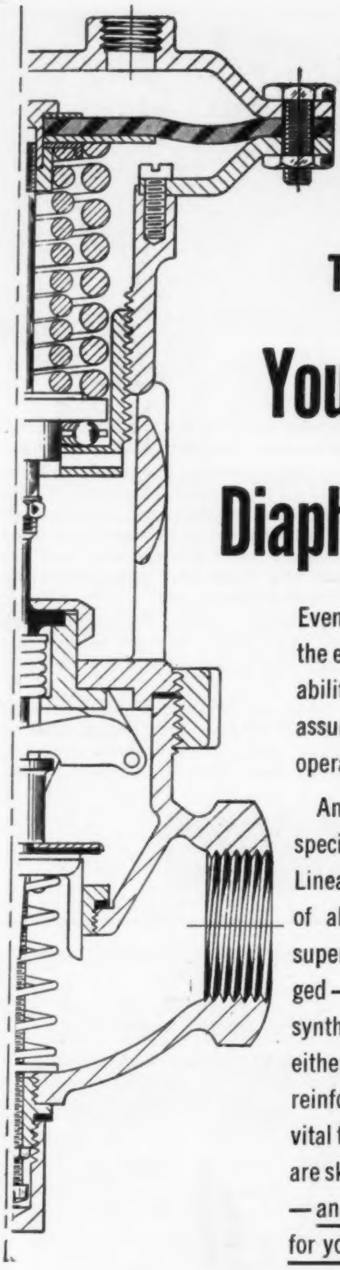

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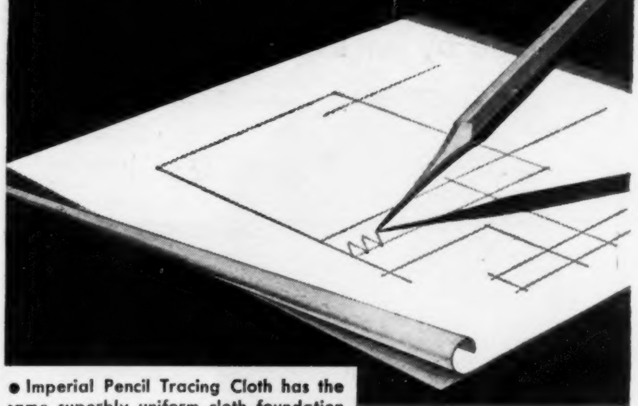

• Imperial Pencil Tracing Cloth has the same superbly uniform cloth foundation and transparency as the world famous Imperial Tracing Cloth. But it is distinguished by its special dull drawing surface, on which hard pencils can be used, giving clean, sharp, opaque, non-smudging lines.

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MECHANICAL ENGINEERING
CARD INDEX

August, 1948 — Vol. 70, No. 8

Representatives—Sales Agencies
Business for Sale
Partnership—Capital
Manufacturing Facilities

OPPORTUNITIES

Positions Open—Positions Wanted—Equipment, Material, Patents, Books, Instruments, etc. Wanted and For Sale

Answers to box number advertisements should be addressed to given box number care of "Mechanical Engineering," 29 West 39th St., New York 18, N. Y.

RATES Classified Advertisements under this heading in MECHANICAL ENGINEERING are inserted at the rate of $1.00 a line 80 cents a line to members of ASME. Seven words to the line average A box number address counts as one line. Minimum insertion charge, 5 line basis. Display Advertisements carried in single column units of multiples of one inch at flat rate of $15 per inch per insertion. Maximum size: 1 column, 10 inches deep; 2 columns, 5 inches deep. Copy must be on hand not later than the 10th of the month preceding date of publication.

POSITIONS OPEN

MECHANICAL DESIGN ENGINEER

With Administrative Experience in the Design of Steam Electric Stations Preferably Between 35 and 45 Years of Age

LARGE EASTERN UTILITY
All Replies Strictly Confidential

Address CA-2483, care of "Mechanical Engineering."

AERODYNAMICISTS
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STRESS ANALYSTS
AIRCRAFT DESIGNERS

North American Aviation has a number of excellent openings for engineers qualified in the fields listed. Salaries commensurate with training and experience. Please include complete summary of training and experience in reply.

Engineering Personnel Office
NORTH AMERICAN AVIATION, INC.
Municipal Airport
Los Angeles 45, California

GRADUATE MECHANICAL ENGINEER

With several years' of laboratory experience for research and development work in excellently equipped mechanical laboratory. Experience in the design and testing of all types of small fans and filters desirable but not essential. Outline your experience and qualifications fully. Interviews may be arranged.

Address reply to: Attention of Executive Engineer

THE HOOVER COMPANY
NORTH CANTON, OHIO

MECHANICAL ENGINEERS

WITH 5 TO 15 YEARS' EXPERIENCE

In Steam or Gas Plant Design

Write to

MECHANICAL ENGINEER
Pennsylvannia Power & Light Company
Allentown, Pa.

POWER STATION TEST ENGINEER

WANTED—GRADUATE MECHANICAL ENGINEER with experience in Power Station Testing, Boiler Water Treatment and Combustion Control Systems. Position is located in a desirable community on the Eastern Sea Coast. Write giving full particulars of education, experience and salary expected.

Address CA-2721, care of "Mechanical Engineering."

DESIGN ENGINEER

Expanding chemical manufacturing company with plants in East and West has opening in New York City for a competent mechanical or chemical engineer with five to ten years' direct experience in plant design and layout work. Good opportunity to progress in developing engineering department. Please submit complete qualification record with salary requirement. Confidences respected.

Address CA-2735, care of "Mechanical Engineering."

SALES ENGINEER

Due to the popularity of S-E-Co. Coal Scales, S-E-Co. Coal Valves, and CONICAL Non-Segregating Coal Distributors, I need an assistant. This man should be about 30 to 40 years old, he must be a graduate engineer and have a college record of B(−) or better and he must have a pleasing personality. Experience in boiler plant operation, boiler plant design, or boiler equipment sales is desirable but I will also consider men without any or only a part of that experience.

The work will consist of assisting sales agents, some direct selling, preparing proposals and writing sales bulletins. Traveling will require about 40–50% of the time. No weekends away from home. Salary.

If you would like to work for a small company that is growing and if you like sales work, this position may prove to be an opportunity to you.

Please write

Arthur J. Stock
Stock Engineering Company
715 Hanna Building
CLEVELAND, OHIO

DEVELOPMENT OR ASSISTANT
CHIEF ENGINEER

A well-established manufacturer of techinical steam specialities requires the services of an imaginative engineer with technical background and experience. This opportunity with a nationally known manufacturer of high pressure valves offers great possibilities for a creative engineer. Please include photograph (which will not be returned) with your application.

Address CA-2734, care of "Mechanical Engineering."

MECHANICAL SALES ENGINEER

With experience in the residential and commercial field of heating and air conditioning.

Aggressive individual with executive ability is desired. Our firm is one of the oldest distributors of Chrysler Airtemp Heating and Air Conditioning equipment.

Please include complete summary of experience in reply, salary expected and date available.

HUNGERFORD, INC.
1604 East Broad Street, Richmond, Va.

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OPERATING SUPERVISOR FOR TONNAGE OXYGEN PLANT

Opportunity in new industry for a man with practical experience in industrial oxygen plants.

Write stating experience, age, education and salary required. Replies held in confidence.

Address CA-2722, care of "Mechanical Engineering."

PIPING DESIGNERS—with 5-10 years' experience, preferably in oil refining. Age 25-40. Salary over $5,000 per year. Opportunities for advancement. Write, stating qualifications, to Mr. E. G. Glass, Jr., The Standard Oil Company (Ohio), 1780 Midland Building, Cleveland 15, Ohio.

DRAFTSMEN—with experience, preferably in oil refining. Age 20-40. Good salary. Opportunities for advancement. Write, stating qualifications, to Mr. E. G. Glass, Jr., The Standard Oil Company (Ohio), 1780 Midland Building, Cleveland 15, Ohio.

FIRST CLASS STRUCTURAL ENGINEER—for design and detail work in a medium sized chemical plant located in central Virginia. Experience in plant layout, piping and mechanical design helpful but not essential. Good opportunity for advancement with a growing concern of national scope. Salary commensurate with ability. All replies strictly confidential. Address CA-2700, care of "Mechanical Engineering."

GRADUATE MECHANICAL ENGINEERS—preferably experienced in plant layout and equipment design wanted for Development Department staffs of large wood products manufacturers in Minnesota and Washington. Submit details education, experience, personal history, salary requirement, references and recent photo. All replies will be considered confidential and will be acknowledged. Address CA-2712, care of "Mechanical Engineering."

ENGINEERS—Large college offers $3000., approximately half-time teaching-studying. Positions of all ranks for Masters, $4500-$6500. Cline Teachers Agency, East Lansing, Mich.

INSTRUCTOR—in Mechanical Engineering for general mechanical courses, industrial engineering, and machine design. Salary: $3500 for eleven months. Write Dean of Engineering, Fenn College, Cleveland 15, Ohio.

Continued on Page 110

POSITIONS OPEN

Continued from Page 109

ASSISTANT EDITOR—Mechanical engineering graduate, 28–35, with several years' experience in steam power plant work. Must be able to write well; not adverse to traveling; and preferably handy with camera. Salary open. Address CA-2717, care of "Mechanical Engineering."

GRADUATE ENGINEER—with experience in Carburetion and Fuel Systems for two cycle engines. Located East Central Wisconsin. State complete qualifications in application. Address CA-2720, care of "Mechanical Engineering."

MECHANICAL ENGINEER—Northern Ohio manufacturer needs experienced die man with metallurgical background. Must know deep drawing of steel and alloys. Should know effects of deep drawing in relation to grain structure, grain flow, strains and stresses, and their control. Medium heavy work on both hydraulic and mechanical presses. M.E. or C.E. degree desirable with at least 10 years' die experience. Write resumé with full details, also reference. Replies held confidential until interviewed. Address CA-2725, care of "Mechanical Engineering."

MECHANICAL ENGINEER—DESIGN—Attractive permanent position for man with proven ability in thermodynamics, designing and planning of electrical, steam and power facilities in process industry. Plant located in northern New Jersey metropolitan area. Furnish full details, age, experience and salary desired. Address CA-2727, care of "Mechanical Engineering."

ENGINEER—MECHANICAL—Graduate, minimum age 30 with at least 5 years' experience in chemical or related industries or with manufacturer of chemical process equipment, competent for assignment as engineer of Catalytic Oxidation Section of large chemical plant. Plant near Pittsburgh, Pa. Experience in design, development and maintenance desirable. Submit complete resumé and salary desired. P. O. Box 193, Bridgeville, Pa.

POSITIONS WANTED

MECHANICAL ENGINEER — 31, Stevens Graduate, Good Electrical background. 2 years' electrical and mechanical drafting in machinery and chemical industries. 3 years' Plant Engineering and maintenance large shipyard. 3 years' diesel-electric power plant operation and maintaince, water distillation plant operation and maintenance, and electronic maintenance as Naval Officer. 1 year plant engineering and maintenance large department store. Presently employed. Desire plant engineering, maintenance or operation. Prefer eastern U. S. Address CA-2701, care of "Mechanical Engineering."

ENGINEERING EXECUTIVE—now employed, 48, married, graduate in M.E., registered professional engineer, member A.S.M.E., over 25 years' experience in designing, constructing, organizing and managing industrial plants here and abroad. Assets: initiative, experience, executive ability; speaks fluent Spanish, some French, Portuguese. Wishes connection with progressive organization as production executive, plant manager, etc. Location preferred: East, Southeast. Will travel abroad. Address CA-2718, care of "Mechanical Engineering."

EXECUTIVE ENGINEER—with broad administrative, manufacturing, engineering, construction, and tooling experience in machinery, aircraft, and paper industries. Seeks responsible administrative position. Address CA-2713, care of "Mechanical Engineering."

DESIGN AND DEVELOPMENT ENGINEER—over 20 years' experience; Development of new product, design of tools and product, research on drawing and forming of metals, supervision of design and inspection. Technical background. Desires permanent position. Prefer location in small or moderate size town. Address CA-2715, care of "Mechanical Engineering."

MECHANICAL ENGINEER—M.E., M.S.—age 29. 8 years experience in instrument design, servomechanisms, production and process engineering. Desires responsible position. Details upon request. Address CA-2719, care of "Mechanical Engineering."

CHIEF ENGINEER—chemical plant, 25 years' experience design, construction and operation chemical and metallurgical plants, desires change of location with position in executive capacity. Excellent engineering background and administrative experience. Address CA-2726, care of "Mechanical Engineering."

DESIGN ENGINEER—Graduate M.E., age 34. Desires employment with company in Power Plant, Water Supply, and Ventilation Design. Nine years' experience, four years as supervisor of other engineers. Present position, Project Engineer. Licensed Professional Engineer. Prefer West Location. Address CA-2728, care of "Mechanical Engineering."

DEVELOPMENT ENGINEER—Seeking position of responsibility with progressive manufacturer or consultant with opportunity to utilize experience and training in process engineering problems. Heat transfer, combustion, drying, food preparation, drug and chemical plant process development and equipment design. At present, chief engineer for liquid processing equipment manufacturer. Age 42. Married. N. Y. P. E. license. Address CA-2731, care of "Mechanical Engineering."

MECHANICAL ENGINEER—Age 36, Degrees M.E. and C.E., and P.E. Licenses. Desires executive position in development, design, or management with responsible company in the chemical or plastic industry. Broad background of valuable diversified experience in engineering. Past three years with consulting company as head of engineering department. Preferred location: North-east or West. Salary $12,000. Resumé upon request. Address CA-2732, care of "Mechanical Engineering."

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AGENTS WANTED FOR MACHINE DESIGNER AND BUILDER—Firm designs and builds special production machines. Want agents to uncover special machine requirements and act as contact. Member of firm will handle negotiations. Work can be incidental to selling other lines of machinery. Commission paid on design and on machines built. Address CA-2716, care of "Mechanical Engineering."

REPRESENTATIVES AVAILABLE

If you need a New York Office and Eastern Representation on sales or engineering matters, we would like to talk with you.

DUNCAN MacKENZIE COMPANY
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Consult **Z. H. POLACHEK**
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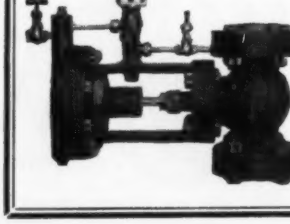
For True Regulation on Boiler Feed Pumps



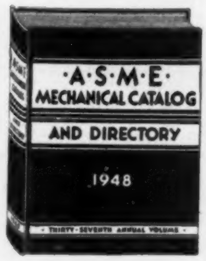
The Genuine
Squires
PUMP GOVERNOR
Catalog H-11 explains
The C. E. SQUIRES CO.
Cleveland, O.

Index To Advertisers

KEEP INFORMED—Pages 41-62 **ENGINEERING SERVICE—Page 112** **OPPORTUNITIES—(classified ads) Pages 109, 110**

✱ **The asterisk indicates that firm also has product catalog in the 1948 A.S.M.E. Mechanical Catalog and Directory**

The Only Reference Annual Covering the Mechanical Engineering Field with a Unique Combination of Complete Equipment Directory and Manufacturers' Catalogs. Up-to-date 20-page Insert Catalog of A. S. M. E. Publications is included.



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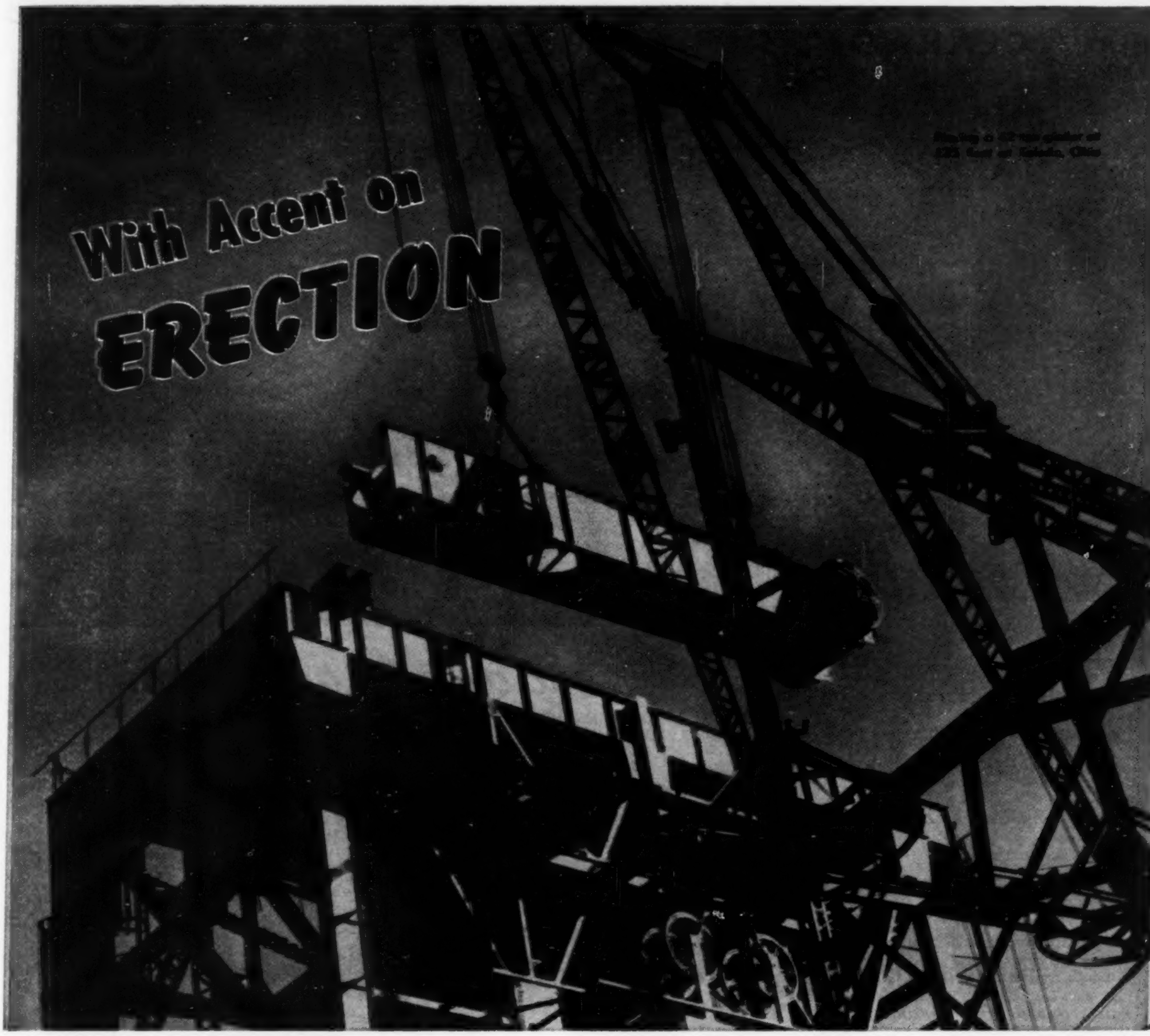
29 West 39th St., New York 18, N. Y.

ENGINEERING SERVICE

Advertisers in Previous 1948 issues but not in this issue



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